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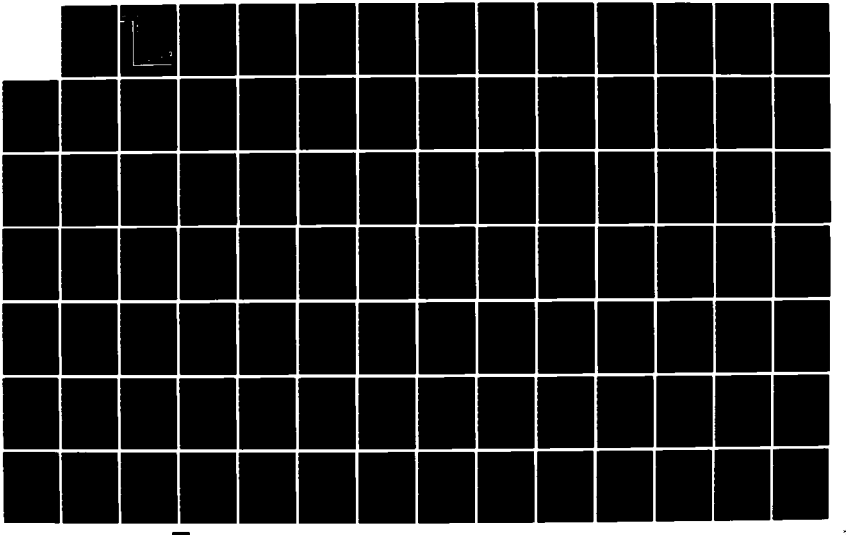

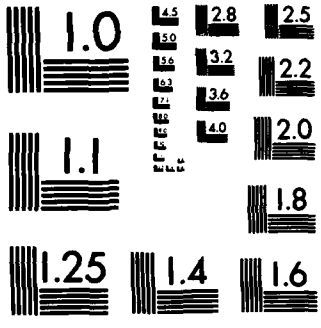

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SELF-PACED INSTRUCTION: FACTORS CRITICAL TO IMPLEMENTATION IN AIR FORCE TECHNICAL TRAINING—A PRELIMINARY INQUIRY

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August 1984
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Self-paced training in the Air Force has not met with the success that had been anticipated from the controlled experiments with self-pacing reported in both the civilian and military literature. The reasons for this lack of wide-scale success were systematically investigated to identify those factors that are critical to the success of the self-paced course. Administative and instructional factors were hypothesized from a review of the literature and were investigated through case studies of 12 courses at four Air Force technical training bases. The results of this study show that it is not one but a combination of factors that primarily influences success and that management factors are more important in Air Force technical training than in the training reported in the general literature. Based on a success model generated by the study, six recommendations are provided for enhancing the successful implementation of self-paced instruction.

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I. INTRODUCTION

History of Self-Pacing in the Air Force

Although rarely acknowledged in the educational and psychological literature, the military has made substantial innovative contributions to the training technology field (Olsen & Bass, 1982). Among these contributions are a total systems approach to training as exemplified by the Instructional Systems Development (ISD) model and the application of cost-effective training methodologies such as self-paced instruction. Despite these advancements in training technology, the implementation of various innovations has not always met with its expected success. In particular, the implementation of various forms of self-paced instruction has been fraught with problems of organizational resistance (e.g., Gissing, 1982; Goldman, 1982). To date, there has been no systematic study of the sources of this organizational resistance and the factors related to the success of self-pacing in the military technical training environment.

Self-paced instruction is a method of instruction in which individual students can proceed through modularized instructional units at their own pace. The instructional units can be presented in a variety of media, e.g., printed programmed texts (PTs), audio-visual materials or on cathode ray tubes as computer-assisted instruction (CAI). An entire course may be presented in a self-paced mode; alternatively, portions of the course may be self-paced while other portions may be taught by more conventional group-paced approaches (e.g., group lectures, group discussions, team activities). These various formats exist to accommodate perceived course content, training needs, and student characteristics unique to a career specialty. The divergence from a purely self-paced format in itself represents the perceived inadequacy of the self-paced method alone to meet all classroom training requirements.

The Air Force has implemented various forms of self-pacing in technical training since the early 1960s (Canfield, 1966; Gissing, 1982; Goldman, 1982; Madsen, 1963; Ofiesh & Meierhenry, 1964; Olsen & Bass, 1982). Much of the impetus was derived from efforts to apply a systems approach (i.e., ISD model) to training as a means of achieving the most effective and efficient training at the least cost (Vineberg & Joyner, 1980). Specifically, in October 1961, Air Force wide interest in programmed learning was expressed in an Air Staff policy letter. A plan for transitioning programmed learning from a research and development stage into an operational stage was presented (Madsen, 1963). In January 1962, an 18-month experiment in developing programmed instruction was begun and by 1979, there were 110 courses that were fully or partially self-paced (Goldman, 1982). About 25 percent of the student load within Air Training Command (ATC) participated in these courses. Since that time, however, the use of self-paced instruction in the Air Force has rapidly declined, with only about 25 courses across ATC now using self-paced instruction (Goldman, 1982).

In tracing the history of the implementation of self-pacing in the Air Force, several key elements can be identified as playing a role in the current status of this training method (Canfield, 1966; Gissing, 1982; Goldman, 1982). These key elements include the following: (a) the ATC decision to apply the ISD model to selected technical training courses in 1963-65, (b) the establishment and later discontinuance of special ISD teams for providing outside support and expertise to training commands, (c) the tendency for outside ISD teams to develop self-paced courses with little involvement and

participation of course personnel, (d) the nearly exclusive use of programmed texts as the vehicle for implementing self-pacing, (e) the tendency to restrict programmed text formats to linearly sequenced texts with little branching or other innovative instructional strategies, (f) the discontinuance of an in-depth ATC course on how to design programmed instruction, (g) the Air Force decision to accept recruits with lower aptitudes (who were generally poor readers), (h) inappropriate preparation of instructors for their new roles in self-paced courses, (i) insufficient validation of instructional materials, (j) inadequate support for the revision and reproduction of audio-visual and printed materials, and (k) the inability, in many cases, to place graduates promptly upon completion of self-paced instruction.

All of the preceding elements played a role in user reactions to the self-paced method for technical training. It is also clear, however, that a number of other factors (e.g., ease of system use, flexibility of implementation approach) may be related to the success or nonsuccess of self-pacing in this context.

Purpose of the R&D Effort

As discussed in the preceding section, self-pacing has not met with its expected success when implemented in the Air Force technical training. Although historically this instructional method has been shown to be pedagogically sound in some small-scale implementations (e.g., research studies with high school and college populations), when implemented on a large scale in the technical training environment its success has been more limited. The reasons for this phenomenon have not been systematically studied, nor have critical factors related to the success of self-pacing in Air Force technical training been identified.

This R&D effort was therefore undertaken in order to systematically study factors that influence or optimize self-pacing and to identify those factors that are decisive to the success of a self-paced course. The overall purpose, then, was to identify and investigate critical factors associated with the successful utilization of self-paced instruction in a variety of formats (e.g., programmed texts, audiovisuals, CAI) within Air Force technical training. Critical factors are defined as those which markedly influence both the real and perceived effectiveness of self-paced instruction, as well as user acceptance of self-paced instruction as a viable instructional method for Air Force technical training. An identification of these factors represents an important step in capitalizing on the promises of the self-paced concept for enhancing the effectiveness and efficiency of future technical training efforts.

II. METHOD

Objectives

The specific objectives of this investigation were (a) to perform a conceptual analysis of literature-based factors most likely to be responsible for the success or lack of success of self-paced instruction, (b) to test the conceptual model using case studies of successful and unsuccessful self-paced courses at selected Air Force technical training centers, and (c) to integrate the findings into a set of critical factors and list of recommendations for the successful utilization of self-paced instruction in Air Force technical training environments.

Approach

The basic approach consisted of the following steps:

1. Analysis of state-of-the-art literature suggestive of factors impacting the design, development, implementation, evaluation, and transition of various forms of self-paced instruction; and integration of findings from the literature with expert opinions from military and civilian sources.

2. Development of a conceptual model of those factors most likely to be related to the successful utilization of self-paced instruction in Air Force technical training, along with a set of hypotheses regarding the relative importance of various factors.

3. Development of a list of criteria for evaluating the success or nonsuccess of self-paced courses in Air Force technical training, and selection of technical training courses that meet the criteria of either successful or unsuccessful utilizations of self-pacing, for participation in a case study test of the critical factors identified in the conceptual model.

4. Development of interview guidelines to be used in the collection of factual and attitudinal information related to the hypothesized factors from a variety of personnel (instructors, supervisors, branch chiefs, material developers, field supervisors) involved with the implementation of the selected self-paced courses.

5. Implementation of the case study methodology in the selected self-paced courses, including the observation of course procedures, review of course materials, collection of information on course and student characteristics, and gathering of historical information related to the use of self-pacing.

6. Reduction and analysis of the case study information; comparison of this information with factors identified in the conceptual model.

7. Development of a list of critical factors and set of recommendations for the successful utilization of self-pacing in Air Force technical training.

Conceptual Model of Critical Factors

An extensive review of literature relevant to the successful and unsuccessful utilization of various forms of self-paced instruction was completed and integrated with information from both military and civilian sources. In general, the civilian literature identified factors related to instructional and implementation issues (e.g., choice of content and presentation mode, user involvement in the implementation of self-paced technologies) whereas the military literature identified factors primarily related to administrative and management issues (e.g., cost effectiveness, staff training). (The literature review is being published as a separate document; see Back and McCombs, 1984.) Military sources contacted included experts involved in self-pacing in the Army, Navy, Marine Corps, and Coast Guard. Civilian sources included experts in instructional technology and computer-based instruction at the University of California-Los Angeles, Human Resources Research Organization, and the PLATO group at the University of Illinois. On the basis of an integration of information from the literature review and experts, a conceptual model of those factors most likely to be related to the successful utilization of self-pacing was derived. This model, shown in Figure 1, lists literature-based critical factors involved in the design, development, implementation, evaluation, and transition phases of self-paced instruction. The model provided a basis for deriving a set of hypotheses to be verified in the case studies.

Hypotheses

A set of hypotheses was generated in order to focus data collection efforts on key factors. These hypotheses also represented a means by which critical factors identified in the literature and by experts could be tested via the case study method applied to the operational training setting. The hypotheses were:

1. The use of a well-formulated implementation strategy which involves the user group in all aspects of self-pacing is critical to the successful utilization of self-pacing.

2. The availability of qualified personnel for the development and maintenance of the self-paced system is critical to the successful utilization of self-pacing.

3. The provision of specialized training in new roles and responsibilities required by all levels of personnel supporting self-paced instruction is critical to the successful utilization of self-pacing.

4. The ability of the user organization to provide necessary personnel and resources to support self-paced instruction in a timely and effective fashion is critical to the successful utilization of self-pacing.

FACTORS PER SYSTEM STAGE	Internal Decision				External Decision			
	In-House Development		Outside Development		In-House Development		Outside Development	
	New Course	Existing Course	New Course	Existing Course	New Course	Existing Course	New Course	Existing Course
DESIGN								
Recognized need/training problem								
Well-defined management structure and plan								
Match of system to environment								
Analysis of system requirements								
Analysis of feasibility								
Compatibility of system and user goals/values								
Long-range fiscal planning								
Well-defined development, implementation, evaluation, transition plans								
Provision for mix of individual and group activities								
System matched to student characteristics/needs								

Figure 1. Conceptual model factors critical to the successful utilization of self-pacing.

FACTORS PER SYSTEM STAGE	Internal Decision				External Decision			
	In-House Development		Outside Development		In-House Development		Outside Development	
	New Course	Existing Course	New Course	Existing Course	New Course	Existing Course	New Course	Existing Course
DEVELOPMENT								
Monitoring of development process								
Feasibility of development time								
Infrequent course changes								
Low turnover in development team								
Development team composition/ staffing matched to development requirements								
Analysis of training requirements								
Training materials tailored to student needs								
Application of appropriate learning concepts in materials development								

Figure 1 (cont.)

FACTORS PER SYSTEM STAGE	Internal Decision				External Decision			
	In-House Development		Outside Development		In-House Development		Outside Development	
	New Course	Existing Course	New Course	Existing Course	New Course	Existing Course	New Course	Existing Course
IMPLEMENTATION								
System easy to use and operate								
Phased/timely implementation of system components								
Monitoring of problem areas								
Procedures/training to handle turnover								
Explicit efforts to enhance user acceptance								

Figure 1 (cont.)

FACTORS PER SYSTEM STAGE	Internal Decision				External Decision			
	In-House Development		Outside Development		In-House Development		Outside Development	
	New Course	Existing Course	New Course	Existing Course	New Course	Existing Course	New Course	Existing Course
EVALUATION								
Criteria for evaluating system matched to system goals								
Criteria for evaluating training matched to training goals								
Measurement instruments and approach matched to criteria								
Support for data collection								

Figure 1 (cont.)

FACTORS PER SYSTEM STAGE	Internal Decision				External Decision			
	In-House Development		Outside Development		In-House Development		Outside Development	
	New Course	Existing Course	New Course	Existing Course	New Course	Existing Course	New Course	Existing Course
TRANSITION/ STABILIZATION								
Availability of funds/ commitment to continuance of system								
Flexibility in adoption of system components								

FACTORS IMPORTANT ACROSS ALL STAGES:

1. User Involvement
2. Communication/Interaction/Feedback at All Levels
3. Orientation/Training in New Roles at All Levels
4. Quality Control
5. Personnel/Resources Support
6. Availability of Qualified Personnel

Figure 1 (cont.)

5. The presence of key personnel within the user group who use creative and flexible approaches to the implementation of self-pacing specifically tailored to training needs is critical to the successful utilization of self-pacing.

6. The use of carefully developed and well-validated instructional materials, in a variety of formats, is critical to the successful utilization of self-pacing.

Criteria for Success

Based in part on discussions with Air Force Human Resources Laboratory (AFHRL) personnel, several criteria for determining the success of various self-paced courses within the selected commands were specified. These criteria were: (See Table 1 for a delineation of specific criteria used per course studied.)

1. Perceived acceptance of self-pacing as an appropriate and effective training method by personnel at various levels within the user group (instructors, supervisors, branch chief, material developers). For the purposes of this study, acceptance is defined as positive attitudes toward self-pacing at all levels within the user organization (course) and/or the institutionalization of the self-paced method within the course. These two aspects of acceptance (i.e., positive attitudes, long-term use) are highly, but not perfectly, correlated.

2. Perceived ability of the self-paced method to efficiently and effectively meet student and training needs unique to a selected course (i.e., demonstrated time savings with acceptable course performance).

3. Perceived ability of students in self-paced courses to effectively meet the requirements as specified in the Specialty Training Standard (STS) and very general statement of requirements in each Air Force career field (i.e., low failure rates).

Success, as defined here, is related to user perceptions of the effectiveness of training in specific Air Force technical training courses, combined with available course performance data (time savings, test scores, failure rates). Cost data were not specifically included in the success criteria due to difficulties in obtaining these types of data and in getting user agreement on what constitutes valid cost data.

Case Study Data Source

The selection of specific courses in Air Force technical training centers included in the case studies, in both the successful and unsuccessful categories, was based on (a) the specified criteria for success, (b) the extent to which a course was self-paced (percentage of the course that was implemented in an individually paced mode), and (c) the type of self-paced format used (e.g., programmed text, CAI). Air Force technical

Table 1

Course Descriptions

Base/Course	Approximate Length	Date SP	Prior Format	Current Format	AFQT Entry Score(s)	Approximate # Students per Year	Success Criteria*
Lowry AFB							
Precision Measuring Equipment (PME)	30 weeks	1974	Lockstep	100% Self-Paced on one shift	65 Electronics	700	Successful per criteria 1,2,3 for high ability students
Inventory Management (IM)	6 weeks	1974	Lockstep	Back to Lock-step in 1981	45 General 50 Administrative	1,800	Unsuccessful per criteria 1 and 3
Aircraft Armament Systems (AAS)	8-12 weeks depending on channel	1974	Lockstep	Back to Lock-step in 1980	45 Mechanical 45 Electronics	3,000	Unsuccessful per criteria 1 and 3
Chanute AFB							
Aircraft Electrical Systems (AES)	15 weeks	1969	Lockstep	100% Self-Paced	35 Electronics	1,100	Successful per criteria 1,2,3
Aircraft Life Support (ALS)	5 weeks	1972	Lockstep	Being converted to 100% Group-Paced	30 General	475	Unsuccessful per criteria 1,2,3
Aircraft Pneudraulics Systems (APS)	10 weeks	1975	Lockstep	100% Self-Paced; Going to Group-Pacing on one block	30 Electronics	500	Unsuccessful per criteria 1,2, 3 for low ability students

*Success criteria are defined on page 10.

Table 1 (cont.)

Base/Course	Approximate Length	Date SP	Prior Format	Current Format	AFQT Entry Score(s)	Approximate # Students per Year	Success Criteria*
Keesler AFB							
Aircraft Control and Warning (ACW)	6 weeks	1972 1978 cell-paced	Lockstep	100% Cell-Paced (small group-paced)	45 General	600	Unsuccessful as self-paced per criteria 1,2,3 Successful as cell-paced per criteria 1,2,3
Sheppard AFB							
Audio-Visual Methods (AV)	2 weeks	1974	Lockstep	100% Self-Paced	N/A	70	Successful per criteria 1 and 2
Instructional Systems Development (Short ISD)	1 week	1972	Lockstep	100% Self-Paced	45 General	337	Successful per criteria 1 and 2
Instructional Systems Designer (Long ISD)	4 weeks	1976	Began as Self-Paced	85% Self-Paced; 15% Group-Paced	65 General	150	Unsuccessful per criteria 1 and 2
Biomedical Equipment Maintenance (BEM)	32 weeks	1972	Lockstep	40% Lockstep; 60% Self-Paced	65 Electronics	100	Successful per criteria 1, 2, 3
Radiologic Specialist (RS)	16 weeks	1972	Lockstep	70% Lockstep 30% Self-Paced with CAI	45 General	240	Successful per criteria 1, 2, 3

training centers currently implementing self-pacing to any degree are at Lowry AFB, Chanute AFB, Keesler AFB, and Sheppard AFB. Contacts established at each of these centers provided specific information on the limited number of courses (less than 25) identified as self-paced, thereby allowing final selection of 12 courses (a significant percentage of the existing self-paced courses) which most closely met the selection criteria for being successful or unsuccessful (see Table 1), were at least 30 percent self-paced, and were representative of different self-paced formats. These contact persons also made arrangements for Denver Research Institute (DRI) personnel to interview designated personnel within the selected courses.

Various levels of personnel were interviewed within each course for the purposes of collecting both factual information (course descriptions, student flow, etc.) and opinions regarding factors important to the success of self-pacing in each course (cost effectiveness, adequacy of instructor training, quality of materials, etc.). These personnel included instructors, supervisors, branch chiefs, and material developers.

A narrative description of the 12 courses selected across the four technical training centers can be found in Appendix A. Table 1 summarizes pertinent course information, including criteria used in classifying each course as successful versus unsuccessful.

Measures Used in Case Studies

A primary source of information for the case studies was the semistructured interview instrument. These instruments contained both factual and attitudinal questions that were designed to develop information to assess the conceptual model of critical factors related to the successful utilization of self-pacing (see Figure 1). Questions were tailored to specific types of individuals within each course. Thus, interview questions were formulated separately for instructors, supervisors, administrators (branch chiefs), training materials developers, and field supervisors. Individuals were interviewed separately by teams of one, two, or three interviewers. Anonymity was guaranteed to each of the interviewees. Copies of these interview questions are contained in Appendix B. In addition to factual and attitudinal interview information, available Air Force evaluation data (student critique, field evaluations), curricula materials, Specialty Training Standards, and Plans of Instruction (POIs) were collected and examined. Observation of classrooms and of training and study facilities provided another source of information for the case studies.

Summary of Case Study Design

The 12 courses involved in this investigation were grouped into successful and unsuccessful categories based on the criteria for success specified previously in this paper. Because of similarity of student population, instructor staff, self-paced format, and length, (although differing in knowledge and performance requirements), the Audio-Visual Methods (AV) and short ISD courses at Sheppard AFB were combined for the analysis of factors related to the success or nonsuccess of self-paced instruction. This grouping of the 12 course configurations into successful and unsuccessful categories is shown in Table 2. It should be noted that the Aircraft Control and Warning (ACW) course

Table 2

Case Study Design

Courses	Successful*	Unsuccessful
Lowry AFB		
Precision Measuring Equipment (PME)	X	
Inventory Management (IM)		X
Aircraft Armament Systems (AAS)		X
Chanute AFB		
Aircraft Electrical Systems (AES)	X	
Aircraft Life Support (ALS)		X
Aircraft Pneudraulics Systems (APS)		X
Sheppard AFB		
Audiovisual (AV) Methods/Short ISD	X	
Instructional Systems Designer (Long ISD)		X
Biomedical Equipment Maintenance (BEM)	X	
Radiologic Specialist (RS)	X	
Keesler AFB		
Aircraft Control and Warning (ACW)		
Self-Paced Version		X
Small Group Cell-Paced Version	X	

*Perceived success based on criteria on page 10.

at Keesler AFB is shown in both the successful and unsuccessful categories. This was done because the course made a transition from totally self-paced to a small group cell-paced format, thus representing a modification of a less successful format to a successful format that more closely met instructional requirements. Placing this course within both categories provides the opportunity to examine the factors related to both success and lack of success within a single course.

III. RESULTS

Approach to Data Synthesis

Responses from interviewees to questions on the interview forms (see Appendix B) were first summarized into (a) factors related to the success of self-pacing, (b) factors related to the lack of success of self-pacing, and (c) other relevant information (e.g., history of self-pacing in that course, course procedures and policies). Information from each interviewee per course was then organized by category of person interviewed (i.e., branch chief, material developers, instructors, supervisors). This procedure enabled the investigators to look at the relative importance of various factors from the perspective of different levels of management within a course, as well as a way to tally the frequency with which factors were cited across categories of interviewees. Appendix C contains the factor listings and frequency information for each course.

Following the tabulation of factors and frequency of factors per course, a conceptual analysis was performed on these data. The objectives of this analysis were (a) to integrate factors that course personnel identified as important with contractor and key ATC personnel knowledge of each course and previous experience (i.e., with information collected on course and student characteristics, from observational information, etc.), (b) to derive a single list of the most critical success and nonsuccess factors for each course, (c) to group the resulting list of critical factors into categories related to issues identified in the literature, and (d) to compile the individual course critical factors into a single chart for purposes of higher order analysis. This chart is shown in Figure 2, wherein courses are grouped into those representing successful and unsuccessful implementations of self-paced instruction. The ACW course, classified separately as successful and unsuccessful implementations, is listed as the dividing mark between these two categories in order to provide a means of isolating those factors that may be most critical overall to the success or failure of self-pacing in military technical training. The following section discusses procedures used in and the results of the higher-order analysis of information in Figure 2.

Higher-Order Analysis of Critical Factors Across Courses and Sites

In order to assess the relative criticality of various factors to the effectiveness of the selected courses, the history and observations of each course were integrated with interviewee responses and key ATC personnel comments using a combination of quantitative and nominal rankings. This integration resulted in the selection of those factors most critical to the success and lack of success of the courses investigated. A weighting system of one, two, or three pluses or minuses was derived for each of the two sets of factors as a means of qualitatively assessing their relative criticality. These weights, by factor and by course, are shown in Figure 2. Also shown in Figure 2 is the breakdown of critical factors into the following categories: Student Issues, Instructor Issues, Implementation Issues, Management Issues, Instructional Materials Issues, Facilities/Equipment Issues, and Resources Issues. (See Appendix D for a definition of factors listed in Figure 2.)

Following the listing of factors identified as critical, separate lists of those factors consistently related to the success or nonsuccess of courses classified into these two categories were created. That is, if three or more of the courses in each category

Critical Factors	Successful Self-Paced Courses					Both		Unsuccessful Self-Paced Courses				
	PME	AES	AV/SHORT ISD	BEM	RS	ACW CP	ACW SP	IM	AAS	ALS	APS	LONG
Student Issues												
High Student Reading Ability	++							--	--	--	--	
High Student Motivation	++							--	--	--		
High Student Maturity	++							--	--	--		
Instructor Issues												
Instructor Remains with Single Class						+++	---					
High Instructor Dedication/Motivation	+	++	+++	+++	+++			--	--	-	-	
Implementation Issues												
Flexible Implementation Approach	+++	+++		++	++	+++	---	---		---	---	--
Flexible Use of 8-Hour Training Day	+++	+++						--		--	--	
Effective Scheduling of Limited Equipment	++	++	+	+++	+++	+++	---		--	--	---	
Adequate Opportunity for Student/Instructor Interactions	++			+	++	+++	---	---	-	-	-	--
Incorporation of Team and Group Activities	++				++	+++	---	--	--	--	--	---
Limited Clerical/Record Keeping Duties for Instructors	+							--		-		
Adequate Procedures for Handling Test Security	+							--	-			
Instructors Assigned to One Block	+	++						--				
Accommodates Student Differences	++					+		---				
Increases Student/Equipment Contact Time	++											
Frequent Student Feedback				++								
Accommodates Individual Student Projects			+++									
Accommodates Student Learning Preferences												--
Effective Manual Student Tracking												-
Provision of Student Orientation												-
Located at Student's Home Base												--
Management Issues												
In-House Development and Implementation	+++	++										
Continual ISD Process	++	++								-		
Method Matched to Field Requirements	+	++		+	+	+++	---	--	---	---	--	-
Method Considered Cost Effective	+	++		+++	+++	+++	-		--			
Permits Higher Student Flow	+	+										
Staff Involvement/Participatory Management		+++		+++	+++			--	-	---	---	
Strong Management Support			++			+++	---	---			--	
Deliberate Efforts to Keep Instructor Motivation High		+++						---		--	-	
Well-Defined Instructor Roles		+++				+	--	--	--	-	-	
Adequate Instructor Role Training	+	++						--	--	--	-	
Deliberate Efforts to Convince Higher Management of Benefits		++						---				
Separation of Self-Paced and ISD Issues		+						---	---			

Note: ± = Factor weights, see page 17 of text.

Figure 2. Critical factors to the success or nonsuccess of courses in case study.

Critical Factors	Successful Self-Paced Courses					Both		Unsuccessful Self-Paced Courses				
	PME	AES	AV/SHORT ISD	BEM	RS	ACW CP	ACW SP	IM	AAS	ALS	APS	LONG
Multilevel Staff Orientation/Training		+						---	---	-		
Low Emphasis on Completion Times						++	--	--	--			---
Frequent Rotation of Instructor Duties		+++								---		
Flexibility in Meeting Regulations		++								--	-	
Infrequent Course Changes									---	---		
Adequate Student/Instructor Ratios				++	+++			---				
Instructional Materials/Issues												
Quality Instructional Materials	+	+	+					-	--	-		--
Standardized Training Curriculum	+	+										
Mix of Media			+						--			--
Low Reading Requirements									--	--		
Method Matched to Knowledge/Performance Requirements			+++	+++	++				--			
Facilities/Equipment Issues												
Well-Planned Facilities	+	++										
Equipment Broken into Components (Trainers)	+	++								--	--	
Reliable Computer Equipment								---				
Sufficient Number of Terminals								---				
Low Requirements for Large, Expensive Equipment	++	++		++						--	---	
Resources Issues												
Adequate Fiscal/Resource Support for In-House Materials Development	++	++						-			-	
Sufficient Number of Instructors for Materials Development	+											

Figure 2 (cont.)

had weightings associated with a particular factor, that factor was defined as being consistently related to success or failure. These listings of factors consistently related to success and lack of success across the six courses in each category are shown in Table 3. Table 4 gives a further breakdown of these factors into (a) those that are generally critical to the success of self-pacing, (b) those that were identified as critical only in successful self-paced courses, and (c) those that were identified as critical only in unsuccessful self-paced courses. That is, factors in (b) and (c) are those in which the inverse was not present in the other set of courses. In addition, Table 4 identifies which of these factors were also identified as critical in the course with versions classified as both successful and unsuccessful--the ACW course.

From the information shown in Tables 3 and 4, it can be seen that student factors (reading ability, motivation, and maturity) were of more concern in the unsuccessful than in the successful self-paced courses--factors related to reading requirements and quality or instructional materials--along with concerns regarding the inflexible use of the 8-hour training day. Of most concern in the unsuccessful self-paced courses, however, were a variety of factors associated with management issues. These factors ranged from the lack of strong management support and of efforts to keep instructor motivation high to lack of adequate orientation and training at all levels and too much emphasis on having students complete the course in the least amount of time possible.

Factors generally associated with successful implementations of self-pacing were those associated with (a) a flexible approach to the implementation of self-pacing, including the effective scheduling of limited equipment, adequate opportunity for student/instructor interactions, and the incorporation of team and group activities, (b) the careful matching of the self-paced method to field requirements and knowledge/performance requirements, (c) the presence of high instructor dedication/motivation toward self-paced instruction combined with staff involvement/participatory management in the implementation of self-pacing; and (d) the use of quality instructional materials in courses that had low requirements for large, expensive equipment for performance portions. Highly related to these factors, successful courses generally considered self-pacing to be a cost-effective training method, whereas this was not the case with unsuccessful courses.

Further factors found to be important, but not as critical, were those given a weighting in two of the successful or unsuccessful courses. These factors are shown in Table 5. Factors already noted as critical have been eliminated from this table to avoid redundancy. An examination of the factors shown in Table 5 shows that those related to success include a number of implementation issues (i.e., assigning instructors to one block rather than requiring them to be responsible for the technical content of the entire course, the dedication to a continual ISD process to maintain course quality, and the commitment to in-house course development and implementation of self-pacing) and management issues (i.e., a recognition of the benefits of self-pacing for permitting higher student flow, and the capability to provide adequate student/instructor ratios). In addition, a variety of materials, facilities/equipment, and resource issues were important to the success of self-pacing (i.e., the capability for self-paced materials to provide a standardized training curriculum, the flexibility and creativity in providing well-planned facilities, the presence of equipment for performance portions of the course that could be broken into components or trainers, and the presence of adequate fiscal and resource support for in-house materials development).

Table 3

Factors Consistently Related to Success or Nonsuccess of Self-Pacing

	Success Factors		Nonsuccess Factors
1.	High Instructor Dedication/ Motivation Toward Self-Paced Instruction	1.	Low Instructor Dedication/Motivation Toward Self-Paced Instruction
		2.	Lack of Deliberate Efforts to Keep Instructor Motivation High
		3.	No Well-Defined Instructor Roles
		4.	Lack of Instructor Role Training
2.	Flexible Implementation Approach	5.	Inflexible Implementation Approach
		6.	Inflexible Use of 8-Hour Training Day
3.	Effective Scheduling of Limited Equipment	7.	Ineffective Scheduling of Limited Equipment
4.	Adequate Opportunity for Student/Instructor Interactions	8.	Inadequate Opportunity for Student/ Instructor Interactions
5.	Incorporation of Team and Group Activities	9.	Lack of Incorporation of Team and Group Activities
6.	Low Requirements for Actual Equipment	10.	High Requirements for Large, Expensive Equipment
7.	Staff Involvement/Participatory Management	11.	Lack of Staff Involvement/ Participatory Management
		12.	Lack of Strong Management Support
8.	Quality Instructional Materials	13.	Low-Quality Instructional Materials
9.	Method Matched to Knowledge/ Performance Requirements	14.	Lack of Multilevel Staff Orientation/ Training
10.	Method Matched to Field Requirements	15.	High Emphasis on Completion Time
11.	Method Considered Cost Effective	16.	Low Student Reading Ability
		17.	Low Student Motivation
		18.	Low Student Maturity

Table 4

General and Unique Factors Associated with the Success or Nonsuccess of Self-Pacing

Factors Generally Critical to Success or Nonsuccess		
1.	High Instructor Dedication/Motivation	
2.	Flexible Implementation Approach	ACW (CP and SP)*
3.	Effective Scheduling of Limited Equipment	ACW (CP and SP)
4.	Adequate Opportunity for Student/Instructor Interaction	ACW (SP)
5.	Incorporation of Team and Group Activities	ACW (CP and SP)
6.	Method Matched to Field Requirements	ACW (CP and SP)
7.	Staff Involvement/Participatory Management	
8.	Quality Instructional Materials	
Factors Identified as Critical Only in Successful Courses:		
1.	Method Considered Cost Effective	ACW (CP)
2.	Method Matched to Knowledge/Performance Requirements	
3.	Low Requirements for Large, Expensive Equipment	
Factors Identified as Critical Only in Unsuccessful Courses:		
1.	Low Student Reading Ability	
2.	Low Student Motivation	
3.	Low Student Maturity	
4.	Inflexible Use of 8-Hour Training Day	
5.	Lack of Strong Management Support	ACW (SP)
6.	Lack of Deliberate Efforts to Keep Instructor Motivation High	
7.	No Well-Defined Instructor Roles	ACW (SP)
8.	Lack of Multilevel Staff Orientation/Training	
9.	High Emphasis on Completion Time	ACW (SP)
10.	Lack of Instructor Role Training	

*This column indicates which factors were most critical to the success or failure of the ACW course, in either its cell-paced (CP) or self-paced (SP) format.

Table 5

Additional Factors Important to the Success or Nonsuccess of Self-Pacing

Success Factors	Nonsuccess Factors
1. Instructors Assigned to One Block	1. Excessive Clerical/Record Keeping Duties for Instructors
2. In-House Development and Implementation	2. Inadequate Procedures for Handling Test Security
3. Continual ISD Process	3. Inflexibility in Meeting Regulations
4. Permits Higher Student Flow	4. Frequent Course Changes
5. Adequate Student/Instructor Ratios	5. Inadequate Mix of Media
6. Standardized Training Curriculum	6. High Reading Requirements
7. Well-Planned Facilities	7. Equipment Cannot be Broken into Components (Trainers)
8. Equipment Broken into Components (Trainers)	8. High Requirements for Large, Expensive Equipment
9. Adequate Fiscal/Resource Support for In-House Materials Development	

Factors shown as important to the lack of success of self-pacing in Table 5 were those generally related (a) to the lack of a creative and flexible implementation of self-pacing (excessive demands on instructor time for clerical and record keeping duties, inadequate procedures for handling test security, and inflexibility in meeting regulations) and (b) to various course and equipment characteristics (frequent course changes due to frequent changes in the field, the requirements for a great deal of reading in acquiring course content without an adequate mix of media, and the high need for large, expensive equipment along with the use of equipment that could not be broken into component parts or trainers).

In addition to the conceptual and empirical analysis of critical factors shown in Figure 2, course and management personnel characteristics of successful and unsuccessful self-paced courses, as derived from course information and observations, were also analyzed. A list of those characteristics that were very important to the successful implementation of self-pacing was derived and is shown in Table 6. These characteristics point to the need for careful selection of courses and management personnel, as based on the analysis of critical factors and observation of characteristics that distinguished successful and unsuccessful self-paced courses. It should be noted that the first two course characteristics (long course, high student flow) refer primarily to characteristics that influence the perceived cost effectiveness of self-pacing. That is, a course must be sufficiently long or have a sufficiently high student flow to have the potential for translating time savings into cost savings. The fourth factor under course characteristics (low need for actual equipment) refers to a requirement in highly performance-oriented courses that enough flexibility in number or kinds of equipment exists to permit effective resource management and scheduling.

Table 6

Course and Management Personnel Characteristics Related to Successful Self-Paced Implementation

	Course Characteristics		Management Personnel Characteristics
1.	Long Course	1.	Flexibility/Creativity
2.	High Student Flow	2.	Understanding of Features and Benefits of Self-Pacing
3.	High Individual Performance Requirements	3.	Sensitivity to Instructor Needs in Self-Paced Environment
4.	Low Need for Actual Equipment	4.	Persistence in Convincing Higher Management of Benefits
5.	Content Requires a Variety of Skills and Activities	5.	Willingness to Get Involved in Solving Problems Associated with Self-Pacing (e.g., instructor role training, resource shortages, instructor time constraints, facilities layout, training equipment problems)

IV. DISCUSSION

Summary of Findings

The major findings of the present investigation were:

1. From the analysis of course characteristics, successful self-paced courses were generally those that were sufficiently long and/or with high enough student flow for course administrators and instructors to perceive cost benefits; courses with high individual performance requirements, and a low requirement for large and expensive equipment; and those in which the content provided a variety of skills and activities.

2. From the observations and analyses of course management procedures and interview responses, successful self-paced courses were generally those in which course management personnel had high levels of flexibility and creativity in their approach to the implementation of self-pacing, had a good understanding of the features and benefits of self-pacing, had a sensitivity to instructor needs in self-paced environments, were persistent in their efforts to convince higher management of the benefits of self-pacing, and had a willingness to get involved in solving problems associated with the implementation of self-pacing.

3. From the analysis of interview responses, factors identified as generally critical to the success or lack of success of self-pacing across the courses selected for case study were high instructor dedication and motivation toward self-paced instruction, a flexible approach to the implementation of self-pacing, the effective scheduling of limited equipment, adequate opportunity for student/instructor interactions, the incorporation of team and group activities, the match of the self-paced method to field requirements, staff involvement and participatory management approach, and the use of quality instructional materials.

4. From the analysis of interview responses, certain factors were identified as critical only in successful courses: the course was considered cost effective, the self-paced method was matched to specific knowledge and performance requirements, and there were low requirements for large and expensive equipment.

5. From the analysis of interview responses, factors identified as critical only in unsuccessful courses were deficiencies in student reading ability, student motivation, and student maturity; an inflexible use of the 8-hour training day, lack of strong management support, of deliberate efforts to keep instructor motivation high, of well defined instructor roles, multilevel staff orientation and training; and a low emphasis on completion time, and instructor role training.

Deliberate efforts to keep instructor motivation high, well defined instructor roles, multilevel staff orientation, and an emphasis on completion time and instructor role training were present in all the successful courses.

Student factors were more likely to be identified as issues in the unsuccessful courses than in the successful ones. This is chiefly due to the higher ability requirements in the successful courses and suggests the possibility that self-pacing is more appropriate for brighter students. In fact, in one of the courses studied (i.e., Precision Measuring Equipment at Lowry AFB), there were four shifts of students, with only the highest ability students placed on the self-paced shift. Originally all shifts had been in self-paced instruction, but management suspected that the more capable students could benefit most from self-pacing and changed the format accordingly.

Perhaps the best example of a successful self-paced course is the Aircraft Electrical Systems Specialist Course at Chanute AFB. No one factor could be identified as causing this course's success; rather, there was a constellation of variables working harmoniously which led to success. The student ability levels were fairly high. The course emphasized individual problem solving, and troubleshooting skills in particular, which appear to be best acquired in the self-paced mode. Instructor dedication was high and a flexible implementation approach was used; these, in turn, were related to strong management support and participatory management.

It should be emphasized, however, that each manifestation of self-pacing is likely to be different, and thus, a flexible approach to implementation must be maintained. In some cases, a self-paced approach may not be the most appropriate form of instruction, and alternatives should be considered. For example, the Aircraft Control and Warning Systems Course at Keesler AFB prepares students to work in teams. Self-paced instruction did not facilitate small team progress, and instructors had difficulty finding enough students at the appropriate stages each day. Difficulties in the lab were further compounded by the need to use actual equipment which could not be subdivided into trainers. Management's creative solution to this problem was to institute a system of small group instruction, known as cell-paced instruction. (See the ACW course description in Appendix A.) It can be seen in Figure 2 that problems which existed in this course when it was self-paced were almost totally reversed and became positive factors when the course went to cell-pacing.

A course that generally accepts students with low reading levels and stresses presentation of information, such as the Aircraft Life Support Systems course at Chanute AFB, is not likely to be successful as a self-paced course when the main method of instruction is programmed texts, which places heavy reading requirements on students. Air Force readability formulas require minimum numbers of syllables per word, notwithstanding the fact that all career fields incorporate some technical terms which are polysyllabic. Further, students frequently become demotivated when they have to spend 8 hours per day reading a programmed text. Several staff personnel suggested alternatives which could improve instructor and student morale and performance. Among these were integration of team and group activities, use of computer-assisted instruction for presentation of material that may otherwise be boring, and use of computer simulation for illustration of points which now go undemonstrated.

At the PLATO lab at Chanute AFB it was learned that when essentially the same lesson that had been presented in a programmed text was converted to CAI, student

performance was improved, and students proceeded through the lesson more rapidly. The success of CAI was attributed to the automatic branching to remedial loops where necessary, the psychological benefit of students not being aware of how many pages they were going through, and enhancement of student interest.

A common problem identified in unsuccessful self-paced courses is that students progress through the blocks very rapidly with little retention. This problem was remedied in the ACW course at Keesler through the introduction of minimum time requirements for each lesson. Such an approach would require management flexibility and de-emphasis on rapid completion times as a quick measure of cost savings. In other cases, with a different student population, the retention problem may be less related to rapid completion times than to too little opportunity for repetition/repeated exposure to new information. In these cases other solutions may be called for (e.g., more individual or group practice, incorporation of lectures or peer tutoring).

In total, a primary finding in this investigation is that no single factor is predominantly responsible for the success or nonsuccess of self-pacing in Air Force technical training. Rather, a combination of factors appears to make the difference. Figure 3 represents a synthesis of study results related to factors that in combination appear to contribute most to the success or lack of success of self-pacing in this environment.

In examining Figure 3, the underlying concept is that for self-pacing to be successful, it must be perceived to be cost effective. That is, instructor and management personnel must perceive that the method is contributing to cost efficiency of training and/or producing quality graduates in terms of training standards and criteria. In turn, this perception is based on the presence of high instructor dedication and motivation and on whether the method is adequately meeting student needs. These latter two factors interact and contribute to each other. The instructor and student factors are independently influenced by a number of management and instructional factors, respectively. The management and instructional factors interact with each other (implying good communication between instructional development and management personnel) as well as operate in combination. Finally, to the extent the factors are present, working well together, and producing perceptions that the self-paced method is cost effective, these perceptions will positively influence the stability of both management and instructional factors. This conception forms the basis for the majority of the recommendations in this paper.

Integration of Findings with Literature

The literature of self-paced instruction was reviewed in this paper for the purpose of investigating factors identified by researchers and practitioners as being important to the success or nonsuccess of self-pacing. No attempt was made to screen the literature to determine the bases from which these allegations and conclusions were published. On the contrary, a conscious attempt was made to investigate an inclusive list of hypothesized factors. A separate analysis of the self-pacing literature (see Back and McCombs, 1984) examines the literature more critically in an attempt to distinguish among studies and to identify the populations studied and the conditions and analyses which led to the published conclusions.

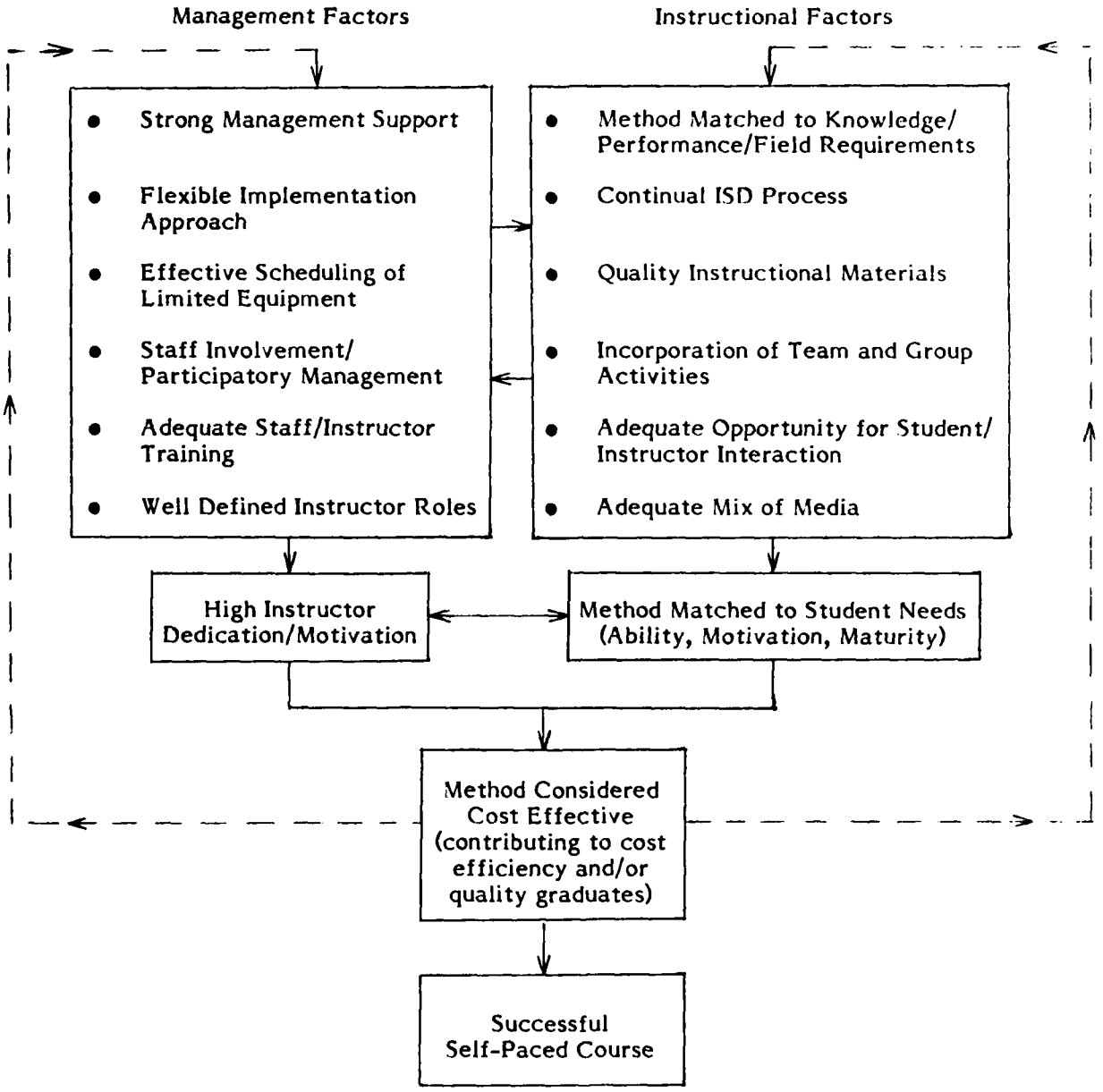

Figure 3. Combination of factors critical to the success of self-pacing in Air Force technical training.

The review of the literature, performed prior to conducting the case study interviews, resulted in a chart of factors hypothesized as critical to the successful utilization of self-pacing (see Figure 1). The major issues identified fell into five categories: Design, Development, Implementation, Evaluation and Transition/ Stabilization. This framework represented a developmental analysis of the process of designing and implementing self-pacing. Thus, here "implementation" refers to the introduction of a completed curriculum to the user, whereas in Figure 2 "implementation" issues refer to the methods used in the course on a day-to-day basis.

A comparison of Figures 1 and 2 yields similarities as outlined in Table 7. Although the terminology sometimes differs, the basic concepts derived from the literature and the case studies are congruent.

A complete investigation of the design and development of the courses studied was beyond the scope of this effort. In most courses studied, the original managers and course authors were no longer available, although every attempt was made to interview those who had been affiliated with the course for some time.

Some of the factors identified in the literature were found to be important in individual course analyses, but were not determined to be critical for success or failure. Among these are the following:

Design

- Compatibility of system and user goals/values
- Well-defined management structure and plan
- Well-defined development, implementation, evaluation, transition plans

Development

- Feasibility of development time
- Low turnover in development team
- Development team composition/staffing matched to development requirements

Implementation

- System easy to use and operate
- Monitoring of problem areas

Across Stages

- Quality control (of materials, instructors, equipment)
- Availability of qualified personnel

Table 7

Similarities of Factors Derived from Literature and from Case Studies

Figure 1 Factors	Figure 2 Factors
• Design: Match of System to Environment	• Management: Method Matched to Field Requirements
• Design: Provision for Mix of Individual and Group Activities	• Implementation: Incorporation of Team and Group Activities
• Design: System Matched to Student Characteristics/Needs • Development: Training Materials Tailored to Student Needs	• Student: High Student Reading Ability, Motivation, Maturity • Implementation: Accommodates Student Differences • Implementation: Accommodates Individual Student Projects • Implementation: Accommodates Student Learning Preferences • Materials: Low Reading Requirements
• Development: Infrequent Course Changes	• Management: Infrequent Course Changes
• Development: Analysis of Training Requirements	• Management: Continual ISD Process • Management: Separation of Self-Paced and ISD Issues
• Implementation: Explicit Efforts to Enhance User Acceptance • Implementation: Procedures/ Training to Handle Turnover	• Management: Deliberate Efforts to Keep Instructor Attitude and Motivation High • Management: Well-Defined Instructor Roles • Management: Instructor Role Training • Management: Multilevel Staff Orientation/Training

Table 7 (cont.)

Figure 1 Factors	Figure 2 Factors
• Transition/Stabilization: Availability of Funds/Commitment to Continuance of Systems	• Management: Strong Management Support • Resources: Adequate Fiscal and Resource Support for In-House Materials Development • Resources: Sufficient Number of Instructors for Materials Development
• Transition/Stabilization: Flexibility in Adoption of System Components	• Implementation: Flexible Implementation Approach • Implementation: Effective Scheduling of Limited Equipment
• Across Stages: Communication/Interaction/Feedback at all Levels	• Implementation: Frequent Student Feedback • Management: Staff Involvement/Participatory Management
• Across Stages: Personnel/Resources Support	• Management: Strong Management Support • Management: Deliberate Efforts to Convince Higher Management of Benefits • Implementation: Limited Clerical Record Keeping Duties for Instructors • Resources: Adequate Fiscal and Resource Support for In-House Materials Development • Resources: Sufficient Number of Instructors for Materials Development

Factors from the literature which apply primarily to new courses but which were not validated by the present study included:

Design

- Recognized need/training problem
- Analysis of system requirements
- Analysis of feasibility
- Long-range fiscal planning

Development

- Monitoring of development process
- Development team composition/staffing

Implementation

- Phased/timely implementation of system components

Several factors identified in the present case studies were not identified in the literature. For the most part these issues pertained to the day-to-day operation of the course and were primarily relevant in only a military setting. Included in these were the following:

Implementation

- Flexible use of 8-hour training day
- Adequate procedures for handling test security
- Effective manual student tracking system
- Located at student's home base

Management

- Higher student flow
- Frequent rotation of instructor duties

Facilities/Equipment

- Equipment broken into components (trainers)
- Reliable computer equipment
- Sufficient number of terminals

Some of these factors were identified in only one or two courses and appeared to be course specific. While the factor "higher student flow" did not appear in the literature, a corollary factor, "saves time" was cited extensively (Dare, Hill, Hall, & Wofford, 1975; Hungerland, 1979; Jamison, Suppes, & Wells, 1974; Kulik, Bangert, & Williams, 1983; Kulik, Kulik, & Cohen, 1980; Orlansky & String, 1979; Sprecher & Chambers, 1980; Zajkowski, Heidt, Corey, Mew, & Micheli, 1979).

The overriding organizing principle in Figure 1 is that of internal vs. external decision to institute self-paced instruction. This issue emerged in the individual course case studies of the Inventory Management (IM) and Aircraft Armament System (AAS) courses, and it was a major focus of Gissing's (1982) analysis of success and nonsuccess factors. Gissing cited imposition of design criteria by an outside team as a major factor in the failure of self-paced instruction. The literature supports the view that the implementor and user should be in agreement on project purposes (Freda, 1980; Freda & Shields, 1980; Lippey, 1975; Plato, 1981; Seidel et al., 1978; Wolcott, 1981).

The second organizing principle, that of In-House Development versus Outside Development was found to be important. Although most self-paced courses were originally developed by an outside curriculum team (e.g., special ATC ISD groups or outside contractors), those courses in which there was adequate fiscal and resource support for in-house materials development and revision were more successful than those in which this support was not available. Gissing (1982) recommended incorporation of users into a team approach in course development. He also recommended the use of a qualified staff of instructional designers and in-house content area experts with training in curriculum development. The literature supports the use of in-house personnel for curriculum development, provided there is adequate training in this area, and release time for instructors (Freda & Shields, 1980; Luskin, Gripp, Clark & Christianson, 1972; Misselt & Call-Himwick, 1978; Seidel & Wagner, 1981; Sprecher & Chambers, 1980).

All courses studied, with the exception of the long ISD course, were existing courses into which self-pacing had been introduced. The "New Course"-"Existing Course" distinction in Figure 1, therefore, was not relevant in the present study.

It should be noted, however, that Kaufman (1982) and Seidel et al. (1978) have stated that if an existing course is satisfactory, then a change in format should not be introduced. A detailed analysis and subsequent selection of those courses which could have benefited most from self-pacing would have been preferable to the across-the-board approach utilized by the Air Force in the late 60s and early 70s. Tailoring an innovation to the particular circumstances in a school or course has been found to be related to successful adoption of that innovation (Charters & Pellegrin, 1973; Hartman & Garnett, 1981; Kearsley, 1977a; Merrill, Towle & Merrill, 1975; Seidel et al., 1978; Shuell, 1978; Wolcott, 1981).

The need for an adequate ISD process prior to initiation of course changes has been noted in the military literature (Berkowitz & O'Neil, 1979; Plocher, Miller, Gardner, & Cronin, 1977; Vineberg & Joyner, 1980), as well as by Gissing. The civilian literature cites the need for activities comparable to the ISD procedure. These include conducting a task analysis (Kearsley, 1977a; Rogers, 1982), specification of goals and objectives (Cohen, 1981; Hartman & Garnett, 1981; Lange, 1967; Rogers, 1982; Shuell, 1978), and systematic instructional design (Kearsley, 1977a; Lange, 1967; Lindvall & Bolvin, 1967; Rogers, 1982; Roblyer, 1981; Shuell, 1978). Likewise, the military literature advocates a

systematic instructional design approach (Freda, 1980; Freda & Shields, 1980; Montemerlo & Harris, 1978; Olsen & Bass, 1982), and precise statement of job performance measures (Training Developments Institute, 1980).

Support for the relevance of most of the factors identified as either critical or important was found in individual studies in the training literature. Figure 4 presents these factors together with citations for literature sources and an indication of whether a positive, negative, or neutral relationship was found between the factor and the success of self-pacing. (A plus indicates a positive relationship, a minus indicates a negative relationship, and a zero indicates no relationship.) Figure 4 further indicates whether the study was done with a military or civilian population. (An "A" indicates an Army population, an "AF" indicates an Air Force population, "M" indicates a Marine population, "N" indicates a Navy population, and a "C" indicates a civilian population.) It should be noted that Figure 4 shows a high level of consensus between military and civilian populations with respect to critical or important factors.

Verification of Hypotheses

The hypotheses generated for this investigation stressed the importance of:

1. An implementation strategy which involves the user group in all aspects of self-pacing

2. The availability of qualified personnel for the development and maintenance of the self-paced system

3. The provision of specialized training in the new roles and responsibilities required by all levels of personnel supporting self-paced instruction

4. The ability of the user organization to provide necessary personnel and resources to support self-paced instruction

5. The presence of key personnel within the user group who use creative and flexible approaches to the implementation of self-pacing specifically tailored to training needs

6. The use of carefully developed and well-validated instructional materials, in a variety of formats, to the successful utilization of self-pacing in Air Force technical training

Translating these hypotheses into definitions developed from the case studies of critical factors, the hypotheses stress the importance of:

1. Staff involvement/participatory management

2. In-house development and implementation

3. Multilevel staff orientation/training

Factor	Source	Effect on[1] Self-Pacing	Population[2]
Student Issues			
• High Student Ability	Blumenfeld, Newman, Johnson, & Taylor (1979)	+[1]	C[2]
	Caffarella, Cavert, Legum, Shotgren, & Wagner (1980)	O*	A,C
	Federico & Landis (1979)	+	N
	Gagne, Reiser, & Larsen (1981)	O*	A
	Hall & Freda (1982)	+	N
	Hartman & Garnett (1981)	O*	C
	Kearsley (1977a)	O*	C
	Kimberlin (1976)	+	A
	Kulik, Bangert, & Williams (1983)	-	C
	Kulik, Cohen, & Ebeling (1979)	0	C
	Kulik, Kulik, & Cohen (1980)	0	C
	Montemerlo & Harris (1978)	+	AF
	O'Day, Kulhavy, Anderson, & Malczynski (1971)	+	N,C
	Zajkowski, Heidt, Corey, Mew, & Micheli (1979)	0	A,AF,N
• High Student Motivation	Caffarella et al. (1980)	O*	A,C
	Misselt & Call-Himwick (1978)	-	AF
	O'Day et al. (1971)	+	N,C
• High Student Maturity	Blumenfeld, Newman, Johnson, & Taylor (1979)	+	C
	Gagne, Reiser, & Larsen (1981)	+	A
	Magarrell (1976)	+	C
	Wang (1980)	+	C

*Authors recommend use of special procedures to accommodate students with low ability and/or low motivation.

[1] + = positive effect on self-pacing; - = negative effect on self-pacing; 0 = no effect on self-pacing.

[2] A = Army; AF = Air Force; M = Marines; N = Navy; C = civilian population

Figure 4. Literature references for critical/important factors.

Factor	Source	Effect on[1] Self-Pacing	Population[2]
Instructor Issues			
• High Instructor Dedication/Motivation	Caffarella et al. (1980)	+	A,C
	Dallman, Grau, Head, & Strickland (1979)	+	AF
	Freda (1980)	+	A
	Freda & Shields (1980)	+	A
	Matlick, Swezey, & Epstein (1980)	+	A
	Plato (1981)	+	C
	Sprecher & Chambers (1980)	+	C
	Tornatzky & Klein (1981)	+	C
	Wollitzer (1977)	+	C
Implementation Issues			
• Flexible Implementation Approach	Hartman & Garnett (1981)	+	C
	Lindvall & Bolvin (1967)	+	C
	Magarrell (1976)	+	C
	Montemerlo & Harris (1978)	+	AF
• Flexible Use of 8-Hour Training Day	None found		
• Effective Scheduling of Limited Equipment	Dallman et al. (1979)	+	AF
• Adequate Opportunity for Student/ Instructor Interactions	Briggs (1977)	+	C
	Dallman et al. (1979)	+	AF
	Kimberlin (1976)	+	A
	King (1975)	+	AF,C
	Misselt & Call-Himwick (1978)	+	AF

Figure 4. (cont.)

Factor	Source	Effect on[1] Self-Pacing	Population[2]
Implementation Issues (cont.)			
• Incorporation of Team and Group Activities	Caffarella et al. (1980)	+	A,C
	Hall & Freda (1982)	+	N
	Lange (1967)	+	C
	Wang (1980)	+	C
• Limited Clerical/Record Keeping Duties for Instructors	Caffarella et al. (1980)	+	A,C
	Dallman et al. (1979)	+	AF
	Kimberlin (1976)	+	A
	King (1975)	+	AF,C
	Van Matre, Pennypacker, & Bortner (1979)	+	M
	Wang (1980)	+	C
	Wilkie (1979)	+	C
• Instructors Assigned to One Block	None found		
• Effective Manual Student Tracking	None found		
Management Issues			
• In-House Development and Implementation	Charters & Pellegrin (1973)	+	C
	Freda (1980)	+	A
	Freda & Shields (1980)	+	A
	Langer (1978)	-	AF,C
	Misselt & Call-Himwick (1978)	+	AF
	Seidel & Wagner (1981)	+	A,AF,C
	Van Matre et al. (1979)	-	M

Figure 4. (cont.)

Factor	Source	Effect on[1] Self-Pacing	Population[2]
Management Issues (cont.)			
• Continual ISD Process	Kimberlin (1976)	+	A
	Kimberlin (1977)	+	A
	Montemerlo & Harris (1978)	-	AF
	Olsen & Bass (1982)	+	A,AF
	Vineberg & Joyner (1980)	+	A,AF,M,N
	Zajkowski et al. (1979)	+	A,AF,N
• Method Matched to Field Requirements	Caffarella et al. (1980)	+	A,C
	Dare, Hill, Hall, & Wofford (1975)	+	A
	Freda & Shields (1980)	+	A
	Hartman & Garnett (1981)	+	C
	Matlick, Swezey, & Epstein (1980)	+	A
	Training Developments Institute (1980)	+	A
	Vineberg & Joyner (1980)	+	A,AF,M,N
• Method Considered Cost Effective	Dallman et al.	0**	AF
	Holmes (1982)	0**	C
	Hungerland (1979)	+0	A
	Kearsley (1977b)	0**	C
	Orlansky & String (1979)	0*,0**	A,AF,N
	Plocher, Miller, Gardner, & Cronin (1977)	+**	N
	Seidel, Rosenblatt, Wagner, Shulz, & Hunter (1978)	0**	A
	Van Matre et al. (1979)	0**	M
	Zajkowski et al. (1979)	0	A,AF,N
• Permits Higher Student Flow	None found		

*Distinguishes time savings from cost effectiveness.

**Discusses methods for determining cost effectiveness.

Figure 4. (cont.)

Factor	Source	Effect on[1] Self-Pacing	Population[2]
Management Issues (cont.)			
• Staff Involvement/Participatory Management	Allen (1977)	+	C
	Charters & Pellegrin (1973)	+	C
	Dallman et al. (1979)	+	AF
	Fairweather, Sanders & Tornatzky (1974)	+	C
	Freda (1980)	+	A
	Freda & Shields (1980)	+	A
	King (1975)	+	AF,C
	Langer (1978)	+	AF,C
	Lippey (1975)	+	C
	Plato (1981)	+	C
	Seidel et al. (1978)	+	A
	Stevens & Tornatzky (1980)	+	C
	Wolcott (1981)	+	C
• Strong Management Support	Dallman et al. (1981)	+	AF
	Hungerland (1979)	0	A
	Seidel & Wagner (1981)	+	A,AF,C
	Seidel et al. (1978)	+	A
	Sprecher & Chambers (1980)	+	C
	Van Matre et al. (1979)	+	M
	Wang (1980)	+	C
• Deliberate Efforts to Keep Instructor Motivation High	Cohen (1981)	+	C
	Freda (1980)	+	A
	Freda & Shields (1980)	+	A
	Johnson (1974)	+	C
	Magarrell (1976)	+	C
	Mayo (1975)	+	C
	Plato (1981)	+	C
	Seidel & Wagner (1981)	+	A,AF,C
	Sprecher & Chambers (1980)	+	C
	Wolcott (1981)	+	C
	Wollitzer (1977)	+	C

Figure 4. (cont.)

Factor	Source	Effect on[1] Self-Pacing	Population[2]
Management Issues (cont.)			
• Well Defined Instructor Roles	Dallman et al. (1979)	+	AF
	King (1975)	+	AF,C
	Shuell (1978)	+	C
• Adequate Instructor Role Training	Cafarella et al. (1980)	+	A,C
	Davidson & Schmitt (1979)	+	C
	Kimberlin (1976)	+	A
	King (1975)	+	AF,C
	Lange (1967)	+	C
	Lindvall & Bolvin (1967)	+	C
	Misselt & Call-Himwick (1978)	+	AF
	Training Developments Institute (1980)	+	A
• Multilevel Staff Orientation/Training	Freda (1980)	+	A
	King (1975)	+	AF,C
	Lange (1967)	+	C
	Plato (1981)	+	C
	Seidel & Wagner (1981)	+	A,AF,C
	Seidel et al. (1978)	+	A
	Training Developments Institute (1980)	+	A
• Low Emphasis on Completion Times	Hartley (1972)	-	C
	Magarrell (1976)	+	C
	Milner (1979)	+	C
• Flexibility in Meeting Regulations	King (1975)	+	AF
• Infrequent Course Changes	Kimberlin (1976)	+	A
	Kimberlin (1977)	+	A
	Lippey (1975)	+	C
	Mayo (1975)	+	C
• Adequate Student/Instructor Ratios	Caffarella et al. (1980)	+	A,C
	King (1975)	+	AF,C
	Misselt & Call-Himwick (1978)	+	AF

Figure 4. (cont.)

Factor	Source	Effect on[1] Self-Pacing	Population[2]
Instructional Materials			
• Quality Instructional Materials	Cafarella et al. (1980)	+	A,C
	Germas (1976)	+	A
	Gibbons, Axtell, & Hughes (1981)	+	AF
	Hartman & Garnett (1981)	+	C
	Kimberlin (1976)	+	A
	Lange (1967)	+	C
	Lippey (1975)	+	C
	Misselt & Call-Himwick (1978)	+	AF
	Ofiesh & Meierhenry (1964)	+	AF,C
	Spitler & Corgan (1979)	+	C
	Wollitzer (1977)	+	C
• Standardized Training Curriculum	Germas (1976)	+	A
	Ofiesh & Meierhenry (1964)	+	AF,C
	Roblyer (1981)	+	C
	Training Developments Institute (1980)	+	A
• Mix of Media	Dare et al. (1975)	+	A
	Gagne, Reiser, & Larsen (1981)	+	A
	Gibbons, Axtell, & Hughes (1981)	+	AF
	Hall & Freda (1982)	+	N
	Harris & Collison (1980)	+	C
	Hartley (1972)	+	C
	Jacobs, Maier, & Stolurow (1966)	+	C
	Kearsley (1977a)	+	C
	Lindvall & Bolvin (1967)	+	C
	Rogers (1982)	+	C
• Low Reading Requirements	Caffarella et al. (1980)	0*	A,C
	Gagne, Reiser, & Larsen (1981)	0*	A
	Johnson (1974)	+	C

*Authors recommend use of special procedures to accommodate students with low reading ability.

Figure 4. (cont.)

Factor	Source	Effect on[1] Self-Pacing	Population[2]
Instructional Materials (cont.)			
• Method Matched to Knowledge/Performance Requirements	Briggs & Wagner (1981)	+	C
	Caffarella et al. (1980)	+	A,C
	Canfield (1966)	+	AF
	Dare et al. (1975)	+	A
	Gagne, Reiser, & Larsen (1981)	+	A
	Gibbons, Axtell, & Hughes (1981)	+	AF
	Kearsley (1977a)	+	C
	Kearsley (1977b)	+	C
	Koch, Englert, Vestewig, & Larson (1981)	+	A
	Milner & Wildberger (1974)	+	C
	Orlansky & String (1981)	+	A,AF,M,N
	Rogers (1982)	+	C
Facilities/Equipment			
• Well Planned Facilities	Caffarella et al. (1980)	+	C
	Kimberlin (1976)	+	A
• Equipment Broken into Components (Trainers)	None found		
• Low Requirements for Actual Equipment	Montemerlo & Harris (1978)	0*	AF
Resources			
• Adequate Fiscal/Resource Support for In-House Materials Development	Freda & Shields (1980)	+	A
	Luskin, Gripp, Clark & Christianson (1972)	+	C
	Milner (1979)	+	C
	Misselt & Call-Himwick (1978)	+	AF
	Montemerlo & Harris (1978)	+	AF
	Sprecher & Chambers (1980)	+	C

*Recommends instructor-led demonstration whenever there is ever a need for actual equipment.

Figure 4. (cont.)

4. Adequate fiscal/resource support for in-house materials development

5. Flexible implementation approach

6. Quality instructional materials

Of these six factors, 1, 3, 5, and 6 were found to be critical to the success of self- pacing, and factors 2 and 4 were found to be important to the success of self- pacing. To a large extent, therefore, the hypotheses were verified in the application of the case study methodology.

A number of other factors found to be critical or important were also found to be highly related to the original hypotheses. These include:

1. Incorporation of team and group activities

2. Method matched to field requirements

3. Method matched to knowledge/performance requirements

4. Flexible use of 8-hour training day

5. Strong management support

6. Deliberate efforts to keep instructor motivation high

7. Well-defined instructor roles

8. Instructor role training

9. Continual ISD process

10. Flexibility in meeting regulations

11. Mix of media

Factors found to be either critical or important to the success of self-pacing which were not directly related to the original hypotheses, included those related to

1. The scheduling and use of limited, large or expensive equipment or equipment which can be separated into component parts

2. Student reading ability, motivation, and maturity

3. The emphases placed on completion time, whether the course was considered cost effective, and whether the method permits higher student flow

4. Instructor dedication/motivation, assignment to blocks, and limited clerical/record keeping duties

5. Well-planned facilities, standardized training curriculum, and procedures for handling test security

These latter factors point to specific issues of importance in the technical training environment and have implications for the recommendations given in the following section.

V. RECOMMENDATIONS

A number of factors were found to be either critical or important to the successful implementation of self-pacing in Air Force technical training. The following recommendations are based on the findings of the present effort.

1. Personnel responsible for the management of self-paced courses should be carefully selected based on their ability to apply flexible and creative approaches to the implementation of self-pacing, their ability to motivate and involve their instructor staff in the implementation of self-pacing, their willingness to get involved in solving problems associated with self-pacing, their understanding of the features and benefits of self-pacing, and their persistence in convincing higher management of the benefits of self-pacing. The results indicated that the more successful self-paced courses were those whose course management provided strong support and staff training, had a participatory management approach, made deliberate efforts to keep instructor motivation high through rewards and frequent rotation of instructor duties, had limited demands on instructor time for clerical and record keeping duties, and maintained an attitude of flexibility in implementing self-pacing and meeting regulations.

2. The implementation of self-pacing in Air Force technical training should be based on a careful and continual application of the ISD process and the match of the self-paced method to both field requirements and the knowledge and performance requirements of a particular job specialty. The results indicated that self-pacing tends to work best in courses with relatively infrequent changes, in sufficiently long courses with high enough student flow to realize cost benefits, in courses that have requirements for a variety of skills and activities, and in courses requiring individual projects with limited need for large and expensive equipment.

3. Carefully designed multilevel staff and instructor orientation and training programs should be developed to provide these personnel with a clear understanding of the features and benefits of self-pacing, flexible approaches to its implementation, and their roles in managing and facilitating student learning in a self-paced environment. The findings in this effort indicated that successful self-paced courses were those in which this type of training was provided, along with opportunities for instructors to apply their own ideas to the solution of training problems.

4. More in-depth training of faculty development and instructor staff in instructional design principles for self-paced courses should be provided to enhance the flexibility, quality, and variety of materials and activities implemented in a self-paced format.

Results of this investigation indicated that quality instructional materials which accommodate student differences and which provide a mix of media and group activities enhance the effectiveness of self-paced instruction.

5. Once self-pacing has been identified as a viable instructional approach through a careful ISD process, adequate fiscal and resource support should be made available to allow maximum implementation of self-paced system components that are highly related to its success. In addition to provisions of adequate instructional supports (e.g., mix of media, instructional development staff expertise, and incorporation of CAI), the findings of this effort indicated that successful self-paced courses are those with the in-house capability to develop and implement self-paced instruction. This implies that under conditions in which adequate expertise and support are present, a strategy which contributes to the success of self-paced instruction in Air Force technical training is one that allows personnel in each course to take responsibility for the development and implementation of a self-paced methodology most appropriate to that course's training needs.

6. The use of self-pacing in courses which enroll students with limited reading skills, low motivation, or low levels of maturity should be carefully planned to include group learning activities and instructional strategies that place minimum demands on reading ability while promoting student interest and personal responsibility skills. This investigation indicated that providing students with an orientation to the requirements of self-paced instruction is helpful for students at all levels of ability, and that self-paced courses with low reading requirements (few programmed texts) and a variety of media and individual and group activities are especially important for low ability, low motivation, and low maturity students.

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APPENDIX A

Course Descriptions

Lowry AFB courses. Three technical training courses at Lowry AFB were examined as part of the case studies. These courses were Precision Measuring Equipment (PME), Inventory Management (IM), and Aircraft Armament Systems (AAS). The PME course was classified as a successful self-paced course and the IM and AAS courses were classified as unsuccessful self-paced courses. The following paragraphs provide descriptions of these courses.

1. PME Course. This is a 30-week course teaching electronics theory, troubleshooting, and repair of measurement equipment. The course is 50 percent knowledge acquisition (Blocks 1-6) and 50 percent performance (Blocks 7-13). PME was lockstep until early 1974, at which time it became one of the four courses chosen for implementation in the prototype Air Force Advanced Instructional System (AIS). From 1974 until 1981, the PME course was self-paced in the computer-managed instruction (CMI) format of the AIS. In late 1981, one of the four shifts was converted to lockstep for low ability students and in 1982, three of the four shifts were converted to lockstep with only high ability students assigned to the one self-paced shift. Students are selected for the self-paced shift on the basis of their scores on a variety of preassessment instruments. Blocks 7-13 are completely performance-oriented and are self-paced for all shifts. Blocks 1-6 are lockstep for three shifts and 100 percent self-paced for one shift. The self-paced shift uses the same texts and programmed materials as the lockstep shifts; the only difference is that students progress at their own rates through the materials on the self-paced shift. General entry requirements for all shifts of the course are a score of 65 on the Electronics scale of the Armed Forces Qualification Test (AFQT). The Trained Personnel Requirement (TPR) for the course is approximately 700 students per year. There are 143 authorized military instructor positions; however, there are currently only 108 military instructors on board. There are also 13 civilian instructors, five of whom are currently dedicated to writing course materials and eight of whom are in the classroom. The instructor/student ratio in the self-paced shift is approximately 1:16 for the knowledge blocks and 1:20 for the performance blocks.

2. IM course. This is an entry-level course for airmen which prepares them for various positions in the Standard Base Supply System, from stock control to equipment management. The course is 6 weeks long and is almost exclusively knowledge acquisition. There are some form completion activities as well. The TPR is 1807 students per year and the course is run on a two-shift schedule. This course has been recently redesigned to a lockstep format. During the time it was self- paced, the facilities included two large and three small learning centers with individual study carrels. Instructors staffed the centers with an instructor/student ratio in the large learning centers of about 3:60 when the course was instituted, to 1-2:60 right before the decision was made to revert to lockstep. The entry requirement is a 45 on the General or 50 on the Administrative subscales of the AFQT. The instructional materials were multimedia during the beginning of the self-pacing era but were narrowed to almost totally programmed text immediately before the conversion to lockstep. Inventory Management was lockstep before 1974; during 1974-1981, the course was redesigned to be self-paced as part of the AIS. In 1981, it was reconverted to lockstep based on field complaints of graduates' competence.

3. AAS course. This is an aircraft weapons loading and maintenance course. Approximately 30 percent of the course is knowledge acquisition and 70 percent is performance. The course, in its current form, has 11 channels, each channel representing training in 11 subspecialties of the career field. The course lasts 58 to 76 days depending on the channel. This channelizaton was initiated in 1979, when it was determined that the current use of representative training was not meeting the field requirements. The TPR for the course averages 3,000 students per year, with daily student loads of 400. There are 111 instructors, 106 of whom are military. Students are required to have a score of 45 on Mechanical or a 45 on Electronics subscale of the AFQT for entrance. At the time this course was self- paced as part of the AIS (1974 to 1979), there were multimedia instructional materials, with a predominance of programmed text, but also including some nonpaper-based materials such as slides and CAI. The AIS-CMI system was in operation from 1975-1980. All performance blocks of the course are conducted in the open area of a large aircraft hangar. Student classes are grouped at the particular aircraft with which they are working. Several such student groups are instructed simultaneously in the same open area. In the middle of the hangar are classroom partitions (no ceilings) for conducting lecture presentations. Surrounding the open hangar area are several enclosed classrooms used also for lectures. The front academic blocks of the course are taught in a separate building consisting of normal classroom facilities. The course was lockstep before 1974. In 1979, the course was channelized and moved back gradually to lockstep. In August 1982, the revised course was officially instituted.

Chanute AFB courses. Three courses were studied at Chanute AFB. These courses were Aircraft Electrical Systems (AES), Aircraft Life Support (ALS), and Aircraft Pneudraulics Systems (APS). The AES course was classified as a successful self-paced course and the ALS and APS courses were classified as unsuccessful self-paced courses. Descriptions of these courses follow.

1. AES course. This is a six-block, 14-week, 4-day course. The course content includes electronics theory, and the troubleshooting and repair of aircraft electrical systems. Approximately 40 percent of the course is knowledge acquisition and 60 percent performance; the format is 100 percent self-paced, utilizing programmed text and video tapes. The TPR is 1,100 students per year, with an entry requirement of 35 on the Electronics subscale of the AFQT. Instructor/student ratios are 1:2 to 1:8 in the labs and 1:12 in the classrooms. There are 12 instructors: 11 military, 5 of whom are pipeline, and 1 civilian. The facilities include separate reading, lab and testing areas in each of the six blocks of instruction. The first two blocks are theory, followed by use of test equipment, then troubleshooting, and finally, actual "hands-on" training with aircraft in the last block. The AES course has been self-paced since 1969, with the course taking total responsibility for the design of self-paced materials and procedures in 1974.

2. ALS course. In this course, students learn to maintain and pack all survival equipment and to manufacture, fit and inspect helmets; fit parachutes; and brief pilots and crew members on survival equipment. The course is 30 percent knowledge acquisition and 70 percent performance, is four

blocks long and takes 27 days to complete. The TPR for the course is 475 students per year and the entry requirement is a score of 30 on the General subscale of the AFQT. The course is currently in transition, moving to 100 percent group-paced from the former self-paced format, which had been in operation for the past 10 years. The primary instructional medium when the course was self-paced was programmed text. Those materials will also be used in the context of lecture and demonstration in the group-paced format.

3. APS course. This course is currently 9 weeks, 4 days long, with four blocks of instruction. The content includes theory and performance on air and fluid systems for aircraft, with approximately 50 percent being devoted to knowledge portions and 50 percent being devoted to performance portions. The APS course was lockstep until 1975, at which time it was determined that a self-paced format would be more cost effective. Self-paced materials are primarily programmed texts, although CAI is used for four lessons in the first two blocks and also for all block testing. The TPR is approximately 500 students per year, and course entry requirements are a score of 35 on the Mechanical or a score of 30 on the Electronics subscales of the AFQT. The instructor/student ratios are 1:5 in performance areas and 1:12 or 1:24 in knowledge areas. There is a current effort underway to develop group-paced instruction for some of the more difficult lessons in Block 3; this represents a modified self-pacing approach for slow students, whereby they go through the standard programmed text, followed by small group discussion facilitated by an instructor.

Keesler AFB courses. One technical training course at Keesler AFB was examined. This was the Aircraft Control and Warning (ACW) Systems Operator course, which was classified as both a successful and unsuccessful self-paced course. The following paragraph provides a description of this course.

1. ACW course. This course consists of aircraft control and warning fundamentals and fundamentals plus practice for both a manual and an automatic aircraft locating and tracking system. The course has three blocks, has a duration of 6 weeks, and is approximately 50 percent knowledge and 50 percent practice/performance. The current student flow is approximately 600 per year, each class consisting of 12 trainees, three instructors, and labs with operations personnel. The course entry requirements are a score of 45 on the General subscale of the AFQT, 11th grade reading ability, higher math aptitude for the aerospace "shred"; and normal color sight, hearing and visual perception. The course is cell-paced, which is defined as small group- paced with three to five students per cell. Each cell is homogeneous by ability level and has one instructor. The instructional medium is programmed text, which is read by all members of a cell while the cell instructor scans the three to five cell members for difficulties with the material. All three cells are in the same classroom. Practice, through simulations, on actual and representative equipment in laboratories follows the classroom portion of the day with the same instructors tracking a cell. The actual job requires teaming, so each cell is a team throughout the course. The instructors are both military and civilian, and have some responsibility for materials revision, working in conjunction with curriculum specialists. This course was lockstep from 1960 to the early 1970s. It was converted to self-paced in the

early 1970s based on an in-house, branch level decision to experiment with self-paced instruction and also to save training costs. In 1978, the course began to evolve to its current cell-paced format as a natural artifact of the job requirements, which include teaming objectives.

Sheppard AFB courses. Five courses at Sheppard AFB were studied: Audiovisual Methods (AV), Instructional Systems Development (Short ISD), Instructional Systems Designer (Long ISD), Biomedical Equipment Maintenance (BEM), and Radiologic Specialist (RS). The Long ISD course was classified as an unsuccessful self-paced course, and the remaining four courses were classified as successful self-paced courses. Course descriptions follow.

1. AV course. This is an in-service course offered through the Faculty Development Division. The course prepares anyone, from sergeant to colonel and civil servants, to develop and deliver audiovisual materials. The course is 50 percent knowledge and 50 percent performance in the form of individual project development. The anticipated student flow for fiscal year 1983 is 70 students. Each class consists of 10 students and one instructor and is conducted in a classroom/lab containing students' desks and equipment such as cameras, projectors, and tape recorders for the performance part of the course. Students are self-selected and there are no specific entry requirements. The course is scheduled for 13 days, has one block, and is approximately 85 percent self-paced. Instructional materials include programmed text and study guides. Individual student-developed AV materials are the performance products of the course. The instructor in this course is a civilian who has taught this and other Faculty Development courses over the years. He is also involved in course revision and outlining. This course was developed in 1971-1972 in a lockstep format. In 1974, the course was redesigned into a self- paced format based upon an Air Force decision.

2. Short ISD course. This is also an in-service course offered by the Faculty Development Division. The course is an introduction to the ISD process, primarily for instructors at the 5- through 7- skill levels in the military and the GS-7 through -9 levels in the Federal Service, and has no specific prerequisites except a score of 45 on the General subscale of the AFQT. This is a 5-day course that is almost completely knowlege acquisition, with no specific performance requirements. The current student flow is 337 per year, with 9 to 12 students and one instructor per class. The facilities include a traditional classroom with desks and cabinets and the multimedia learning center. Self-pacing is the mode for 95 percent of the course, with a brief group-paced introduction comprising the remainder. Workbooks, study guides and film are the instructional materials formats. The instructor for this course is a civilian and is responsible for updating and authoring course materials. This course was reported to have been converted to self-pacing in the early 1970s because of student criticism of the lockstep mode.

3. Long ISD course. This is a third in-service course for instructors and training developers, offered by the Faculty Development Division. The course content includes a detailed investigation of the five steps in the ISD model and requires individual student project development, making the course 50 percent knowledge acquisition and 50 percent performance,

in the form of projects. The current TPR is 150 students per year, with 9 to 12 students per class to one instructor. The entry requirement is a score of 65 on the General subscale of the AFQT. As in most of the other courses offered by Faculty Development, this course is primarily for the Air Force training staff, who are required to take a certain number of credit hours of instruction per year. The course consists of five blocks, has a 20-day duration, and is approximately 85 percent self-paced. The remaining 15 percent is divided among a group-paced course introduction the first 2 days of the course and four round table discussions scheduled toward the beginning of the course. The media employed in this course include study guide/workbooks, programmed text, film loops, slide tape presentations, and some Air Force ISD development manuals. The facilities include a classroom with study carrels and a learning center for nonpaper-based media presentations. The instructors are civilians, there are no pipeline instructors, and the instructors are responsible for the revision and outlining of course materials. This course was initiated in 1976, in a self-paced format. The decision to establish the course and to use self-pacing was made in-house at a time when there were several other self-pacing initiatives at Sheppard AFB and elsewhere in the Air Force.

4. BEM course. This is a course in the School of Health Care Sciences. The course teaches entry-level individuals or cross-trainees how to install, inspect, maintain, and modify representative biomedical and dental equipment used in the Air Force. Approximately 60 percent of the 32-week course is performance and 40 percent knowledge and fundamentals. There are currently, approximately 100 graduates of this course per year and the instructor/student ratio averages 3:10, although it is variable among blocks. The entry requirement for the course is a score of 65 on the Electronics subscale of the AFQT. The prerequisites to Block 1 consist of an electronics principles block and several noncourse content-related CAI lessons concerned with safety and security. The first three blocks of the course are conventionally taught, lockstep classroom instruction. The last three blocks are self-paced, in which students use programmed texts and study guides in preparation to diagnosing problems and repairing over 40 pieces of representative actual equipment in three labs. In the performance blocks, the instructor/student ratio approaches 1:3 and students are evaluated on their troubleshooting process as well as product. All instructor personnel are military, none is a "pipeline" instructor, and all are responsible for course authoring and revision. Portions of the course were converted from lockstep to self-paced in the early 1970s; the decision was made in-house probably by course level managers when more separate pieces of equipment were added to the course.

5. RS course. This is a second course in the School of Health Care Sciences. The course is the first of a three-phase program to train individuals to be radiologic (x-ray) technicians, responsible for taking and processing films. Phase 1--this course provides the knowledge/theory base for the specialty. It lasts 14 to 16 weeks and includes some practice positioning "phantoms" (dummies). Approximately 70 percent of the course is theory and 30 percent is performance. Phase 2, taking place in an operational and training center, is a practicum lasting 38 weeks. The TPR is currently 240 sudents per

year and the instructor/student ratio is variable: 1:4 in performance, 1:8 in the self-paced learning center, 1:12 in the lockstep blocks. Entry requirements for this course include a score of 45 on the General subscale of the AFQT, high school algebra, an 11th grade reading level, and over 19 years of age. The course consists of 10 blocks. Nine of the 10 blocks include classroom instruction followed by demonstrations in x-ray rooms, called "chambers." One block, at the end of the course, is self-paced and employs programmed text, slides, film loops, and one CAI lesson on contrast studies. After studying the in-depth, self-paced materials, the student practices the positioning just studied on phantoms in the chambers. This one block comprises approximately 35 percent of the length of the course. Four other CAI lessons on safety and security are a requirement of the School, not the course, and are scheduled toward the beginning of the course. All instructors are military personnel; none is a "pipeline" instructor; and all instructors have research and revision responsibilities for course materials, including the addition of new materials as new equipment such as CAT scanners appear in the field. This course was established in the 1950s, and the self-paced portion was instituted about 10 years ago when the course was lengthened and then divided into phases. The decision to convert to self-pacing was made in-house, probably at the course supervisor level.

APPENDIX B

Interview Questions Used in Case Studies

ADMINISTRATORS

(Upper Management)

1. When the operational requirements for a course were received from the field, what procedures were followed to initiate training development (specification, task analysis, etc., and communications with the field)?

2. Was the course developed in-house or was the development team external to ATC? Who made the decision and what were the considerations?

3. Who made the decision to have the course administered self-paced vs. group-paced? What were the reasons for the decision and who was involved? Did field input have an impact on decision to self-pace?

4. What do you think of self-paced vs. lockstep instruction?

5. Who decided upon the amount of time required to develop the course? Was the development time considered reasonable by the field, the curriculum developers, the ATC administration?

6. Who monitored the course development process? Who was responsible for approving the product for use?

7. Was there a development plan for the course, including the training of the development team in techniques of instructional materials administered in a self-paced environment?

8. Was there an implementation plan, including training for instructors, trainees and noninstructional personnel in techniques of administering and/or taking self-paced instruction?

9. Have the operational requirements in the field, the trainee characteristics, changed over the last year? How?

10. Are there ongoing performance, training, course materials, evaluation plans? What have been and are the stages of evaluation of this course?

11. What impact have standard evaluations and IG visits had on the course?

12. Has this course proven to be cost effective? What cost factors are considered?

13. What are the long-range fiscal plans for support of this course?

14. Do current regulations support/hinder development and implementation of self-paced instruction?

15. What feedback do you receive about the course from:

- field command/supervisors
- course supervisors
- evaluators
- instructors
- trainees

16. What is your assessment of the success of this course? Why?

ADMINISTRATORS

(Instructor Supervisors)

1. Describe the organizational structure for the implementation of this course. Are there enough personnel? What are the responsibilities of each member?

2. What is the turnover rate of instructor personnel in this course? What effect does the rate have (if high)?

3. What are your duties and responsibilities in the course?

   a. development

   b. delivery

   c. modification

4. What do you think of self-paced instruction vs. lockstep?

5. Is the system easy to manage and use?

6. How were you prepared to administer and manage a self-paced learning environment?

7. Do you provide training to students and instructors about their responsibilities in the context of self-pacing?

8. Have student characteristics and/or performance changed over the last year?

9. What branches of the service use the course to train their personnel? Are there foreign nationals taking the course?

10. Is the physical environment well designed for self-pacing (quiet study areas/carrels, adequate ventilation, light, etc.)? What, if any, improvements have been made?

11. Is the equipment, if any, reliable? What is the student-equipment ratio?

12. How do you manage the instructional resources (equipment malfunctions, reproduction of paper-based materials, etc.)?

13. Are student data reports giving you the information you need? How do you use it? Do you have any recommendations for report format changes?

14. What feedback do <u>you</u> receive about the course from:

    - instructors

- trainees

- evaluators

- ATC administration

- the field

How do you use that information?

15. What impact, if any, have standard evaluations and IG visits had on the course?

16. Do current regulations support/hinder development and implementation of self-paced instruction?

17. What is your assessment of the success of this course? Why?

INSTRUCTORS

1. How long have you been an instructor in this course? How many times in the past year have you taught this course? Is this your first self-paced experience?

2. Have you (do you) also teach group-paced courses?

3. What do you think of self-paced vs. lockstep instruction?

4. Were you, or one of your predecessors, part of the course development process? What was your role?

5. Are instructors part of the course revision/updating process? What are the procedures?

6. What impact have standard evaluations and IG visits had on the course?

7. If you have suggestions for changes, who do you tell? What is the procedure? What has been the outcome? How long before changes appear? Do you make temporary changes on your own?

8. What are your classroom duties? Do you think you should be doing something else? What?

9. Are there enough personnel to cover the instructional and administrative requirements of the course?

10. Do current regulations support/hinder development and implementation of self-paced instruction?

11. Is the self-pacing easy to administer? What do you do for students who are having trouble?

12. If CAI--What do you do if the equipment that delivers instruction breaks down?

13. Is the physical environment well designed for self-pacing (quiet study areas/carrels, adequate ventilation, light, etc.)? What, if any, improvements have been made?

14. Is the equipment, if any, reliable? What is the student-equipment ratio?

15. How do you manage the instructional resources (equipment malfunctions, reproduction of paper-based materials, etc.)?

16. Are student data reports giving you the information you need? How do you use it? Do you have any recommendations for report format changes?

17. How well do most students handle the responsibility of managing their learning in a self-paced environment? Were they trained in time management or other skills useful to trainees in a self-paced environment?

18. What feedback do you receive about the course from:

    - trainees

    - the course supervisor

    - the field

    - evaluators

19. What is <u>your</u> assessment of this course? (Does it meet the field's operational requirements? Should it be self-paced? Is it well administered?)

CURRICULUM DEVELOPERS

(Instructional Designers and Developers)

1. Describe the organizational structure for the development of the course. (What were the roles and the responsibilities?)

2. When the operational requirements for a course were received from the field, what procedures were followed to initiate training development (specification, task analysis, communications with the field, etc.)?

3. Was the course developed in-house or was the development team external to ATC? Who made the decision and what were the considerations?

4. What do you think of self-paced vs. lockstep instruction?

5. Who made the decision to have the course administered self-paced vs. group-paced? What were the reasons for the decision and who was involved? Did field input have an impact on decision to self-pace?

6. Who monitored the course development process?

7. Who were the key personnel and what was their turnover rate during development? What was the effect of the turnover?

8. What training, if any, did the development staff members have for their positions? Were they specifically trained in the special attributes of the self-paced environment?

9. Describe the course development process. (What the communications were among the staff members, how long the steps took, were there plans for the management for the task?)

   - task analysis (specification)

   - development of objectives/mastery criteria

   - sequencing

   - match of instructional strategy to content and student characteristics (Was this accomplished?)

   - selection of the delivery medium and of the self-paced environment (Did field requirements have an impact on the decision?)

   - planning of instructional environment (physical)

   - actual materials development

   - validating content and pilot testing

- revision process

- installation

10. Who specified the amount of time for course development? Was the decision reasonable?

11. Do current regulations support/hinder the development and implementation of self-paced instruction?

12. Is there provision for updating/changing the course materials? What is the plan, who manages revision, how often do changes actually occur?

13. What impact have standard evaluations and IG visits had on the course?

14. Is this course matched to <u>current</u> student characteristics and to <u>current</u> field requirements?

15. Do you have students from different services? From other countries? If so, what impact does that have on the course?

16. How is remediation designed and who implements it?

17. What feedback do <u>you</u> receive about the course from:

    - trainees

    - instructors

    - course supervisors

    - field supervisors

    - evaluators

    How do you use that information?

18. What is your assessment of the success of this course? Why?

19. How do instructors get chosen, trained, monitored, performance evaluations?

APPENDIX C

Tabulation of Factors Related to the Success or Nonsuccess of Self-Pacing per Course

(See Appendix D for definitions of factors.)

Lowry AFB

Precision Measuring Equipment (PME) -
Successful Self-Paced Course

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
1. Adequate Mix of Media	///		/	/
2. High Student Reading Ability	//		/	/
3. High Student Motivation	///			//
4. Flexible Implementation Approach	/		/	
5. Provision of Student Orientation	/			/
6. Multilevel Staff Training	/			/
7. Adequate Instructor Role Training	//		//	/
8. Continual ISD Process	/			/
9. Low Reading Requirements	/		/	/
10. Adequate Opportunity for Student/ Instructor Interactions	/		/	
11. Frequent Student Feedback	/		/	/
12. Adequate Fiscal and Resource Support for In-House Materials Development	/		/	
13. Adequate Course Development Time	//		//	
14. Method Matched to Field Requirements	//			
15. Method Considered Cost Effective	/			
16. Permits Higher Student Flow	/			
17. Effective Scheduling of Limited Equipment	/		/	/
18. Accommodates Student Differences	/			
19. High Quality Instructional Materials	/			/

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
20. High Instructor Dedication/Motivation			//	/
21. Limited Clerical/Record Keeping Responsibilities for Instructors				/
22. Increases Student/Equipment Contact Time			/	
23. Incorporation of Team and Group Activities			/	
24. Adequate Instructor Selection			/	
25. Adequate Procedures for Handling Test Security			/	
26. Standardized Training Curriculum				/
27. Mature Students				/
28. Adequate Remedial Programs				/
29. Well-Planned Facilities				//
30. Comfortable Carrels				//
31. Flexible Use of 8-Hour Training Day			//	

Lowry AFB

Inventory Management (IM) -
Unsuccessful Self-Paced Course

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
1. Insufficient Number of Instructors	/		////	//
2. Low Student Motivation	/		//	/
3. Low Student Reading Level			/	/
4. Prior Student Experience with Self-Pacing			/	
5. Inappropriate Instructor Role Training	/		///	/
6. Computer Breakdowns	/		////	
7. Insufficient Number of Terminals			/	
8. Good for Knowledge Portions Only	/			
9. Method Not Matched to Field Requirements	/			
10. Confounding of Self-Pacing and ISD Issues	/		/	
11. High Reading Requirements	/		/	
12. Inadequate Mix of Media	//		///	//
13. Uncomfortable Carrels	/		/	
14. Lack of Management Support	//		/	/
15. Lack of Instructor Dedication/Motivation	/		//	/
16. Lack of Staff Involvement/Participatory Management	/			
17. Low Quality Instructional Materials	/			/
18. Too Much Emphasis on Completion Time	/		/	/
19. Inadequate Opportunity for Student/ Instructor Interaction			////	//

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
20. Inadequate Training for Materials Development	/		/	/
21. Inflexibility in Meeting Regulations	/		////	/
22. Poor Instructor Selection				/
23. Instructor Burnout			////	/
24. Immature Students			/	
25. Inadequate Opportunity for Student/ Student Interaction			//	
26. Inflexible Use of 8-Hour Training Day			/	
27. Inadequate Fiscal/Resource Support for In-House Materials Development	/		////	/
28. Excessive Demands on Instructor Time and Skills	/		////	
29. Method Considered Not Cost Effective				
30. Student Abuse of Preassessment Process (Purposefully Fail)			/	
31. Standard Evaluation is Not Appropriate for Self-Pacing	/		/	
32. Inadequate Procedures for Handling Test Security			/	
33. No Class Unity			/	
34. Short Course	/		/	
35. Multitrack Programmed Texts were Converted to One Track, Resulting in Boredom			/	
36. Poor Turnaround Time for Materials Revision	//			
37. Inadequate Student/Instructor Ratios			/	
38. Inadequate Training for Complexity of CMI System			/	

Lowry AFB

Aircraft Armament Systems (AAS) -
Unsuccessful Self-Paced Course

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
1. Immature Students	/		//	
2. Low Student Reading Ability			/	
3. Inadequate Student/Instructor Ratios	/	//		
4. Inadequate Team and Group Activities	/	/	////	/
5. Lack of Instructor Dedication/Motivation			//	//
6. Inadequate Opportunity for Student/ Instructor Interactions			//	
7. No Well-Defined Instructor Roles			/	
8. Inadequate Instructor Role Training			/	
9. Inadequate Fiscal/Resource Support for In-House Materials Development			//	
10. High Reading Requirements			/	
11. Inadequate Mix of Media			/	/
12. Low-Quality Instructional Materials		/	//	
13. Lack of Staff Involvement/Participatory Management	/			
14. Too Much Emphasis on Completion Time	//	/	//	/
15. Low Student Motivation			//	
16. Inadequate Procedures for Handling Test Security	//		/	
17. Frequent Course Changes	/			
18. Method Not Matched to Field Requirements	/	/	////	/

Chanute AFB

Aircraft Electrical Systems (AES) -
Successful Self-Paced Course

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
1. Frequent Rotation of Instructors		/	/	//
2. Well-Defined Instructor Roles		/	/	//
3. Staff Involvement/Participatory Management		/	//	/
4. Flexible Implementation Approach	/	/		/
5. Deliberate Efforts to Keep Instructor Attitude and Motivation High		/		//
6. Low Equipment Costs		/		
7. Equipment Broken into Components (Trainers)		/		/
8. Adequate Fiscal and Resource Support for In-House Materials Development	/	/		
9. Method Considered Cost Effective		/		//
10. Provision of Student Orientation		/		
11. Adequate Instructor Role Training	/	/		/
12. Integration of CAI and Other Media	/	/	/	
13. Incorporation of Team and Group Activities	/	/	/	
14. Continual ISD Process	/			/
15. Effective Scheduling of Equipment	//		//	/
16. Deliberate Efforts to Convince Higher Management of the Benefits of Self-Pacing	/			/
17. Standardized Training Curriculum	//			/
18. Enhancement of Student Confidence and Responsibility	/			

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
19. Good for Knowledge Portions Only	/	/	//	
20. Shortage of Actual Training Equipment		/		
21. Inadequate Training for Materials Development	/		//	
22. Confounding of SP and ISD Issues	/	/	/	
23. Infrequent Student Feedback			/	/
24. Method Considered Not Cost Effective		/		
25. Ineffective Scheduling of Limited Equipment			/	
26. Does Not Accommodate Student Learning Preferences			/	

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
19. Low Reading Requirements	/		/	/
20. High Student Motivation	/			
21. Separation of Self-Pacing and ISD Issues	/			
22. Multilevel Staff Orientation/Training	/		/	
23. Accommodates Student Differences			/	/
24. Infrequent Course Changes				/
25. Flexibility in Meeting Regulations				/
26. Permits Higher Student Flow	/		/	
27. Adequate Opportunity for Student/ Instructor Interactions			//	/
28. Low Requirements for Actual Equipment				/
29. Shortage of Field-Experienced Instructors				/
30. Low Emphasis on Completion Time	/		//	
31. Low Demands on Instructor Time and Skills				/
32. Limited Clerical/Record Keeping Responsibilities for Instructors			/	
33. Flexible Use of 8-Hour Training Day		/	/	/
34. Well-Planned Facilities		/	/	/
35. Method Matched to Field Requirements	/			/
36. Limited Resources to Optimize Method	/			
37. CAI Integration Would Optimize Method	/	/	/	

Chanute AFB

Aircraft Life Support (ALS) -
Unsuccessful Self-Paced Course

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
1. Lack of Staff Involvement/Participatory Management		/		
2. Method Does Not Meet Field Requirements	/	/		//
3. Low Student Reading Ability		/	/	/
4. Immature Students	/	/	/	/
5. Frequent Course Changes	//	/		
6. High Reading Requirements		/		/
7. Inadequate Instructor Selection	/	/		
8. Lack of Group and Team Activities	/		//	/
9. Lack of Continual ISD Process				/
10. Shortage of Actual Training Equipment	/			/
11. Equipment Cannot Be Broken into Components	/			
12. Inflexibility in Meeting Regulations	//			
13. Low Quality Instructional Materials			/	/
14. Inadequate Testing of Student Understanding				/
15. Excessive Demands on Instructor Time and Skills				/
16. Inadequate Procedures for Instructor Evaluation				/
17. Low Dedication/Motivation of Instructors			/	
18. Inadequate Rotation of Instructor Duties	/			

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
19. Inflexibility of Implementation Approach	/			/
20. Inadequate Course Development Time	/			
21. Inflexible Use of 8-Hour Training Day		/	/	/
22. Lack of Multilevel Staff Orientation/ Training		/		
23. Inadequate Instructor Role Training		/		

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Audiovisual Methods (AV)/Short ISD -
Successful Self-Paced Course

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
1. Accommodates Student Learning Preferences	//	//	///	//
2. High Student Reading Ability	///	//	///	///
3. Mature Students	/		//	//
4. High Student Motivation	//		/	//
5. Inadequate Instructor Role Training	//		/	//
6. Adequate Student/Instructor Ratios	/			/
7. Limited Flexibility in Implementation Approach	//			//
8. Low Turnover of Instructor Staff				//
9. High Instructor Dedication/Motivation	//			/
10. Adequate Mix of Media	//		/	//
11. High Quality Instructional Materials	//		/	/
12. Method Matched to Field Requirements	//			
13. Low Emphasis on Completion Time	//			/
14. Located at Students' Home Base	//			
15. Accommodates Individual Student Projects	//		/	//
16. Content Can Be Broken into Small Sequential Steps	//			/
17. Adequate Incorporation of Team and Group Activities	/			
18. Adequate Instructor Training for Curriculum Development		/		

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
19. Good for Performance Components	/		///	/
20. Effective Manual Student Tracking				/
21. Provision of Student Orientation	/			
22. Strong Management Support	//	/		
23. Effective Scheduling of Limited Equipment			/	

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Instructional Systems Designer (Long ISD) -
Unsuccessful Self-Paced Course

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
1. Does Not Accommodate Student Learning Preferences	//	/	/	//
2. High Student Reading Ability	//	/	/	/
3. Method Not Matched to Field Requirements	/			
4. Insufficient Number of Instructors for Materials Development			/	/
5. Inadequate Student/Instructor Ratios	/			/
6. Limited Flexibility in Implementation Approach		/	//	//
7. High Instructor Turnover				/
8. Low Instructor Dedication/Motivation				/
9. Inadequate Mix of Media	/			/
10. Complexity of Teaching Students How to Develop Self-Paced Materials	/		/	/
11. Too Much Emphasis on Completion Time	/	/	/	//
12. Not Located at Students' Home Base	/			
13. Accommodates Individual Student Projects	//	/	/	//
14. Inadequate Incorporation of Team and Group Activities	//	/	//	//
15. Inadequate Instructor Training for Curriculum Development	/			
16. Ineffective Manual Student Tracking				/
17. No Provision of Student Orientation	/			

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
18. Inadequate Opportunity for Student/ Instructor Interactions	/	/	//	//
19. Inadequate Instructor Role Training	/	/		/
20. Method Does Not Meet Student Expectations	/	/	/	
21. Limited Resources to Optimize Method		/		
22. Low-Quality Instructional Materials	//			

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Aircraft Pneudraulics Systems (APS) -
Unsuccessful Self-Paced Course

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
1. Permits Higher Student Flow		/		
2. Long Course Length		/		
3. Inadequate Mix of Media	/	/	/	
4. Inflexible Implementation Approach	/	/	/	
5. High Reading Requirements	/	/	/	
6. Low Student Reading Ability	/	/	/	/
7. Lack of Group and Team Activities		/		//
8. Inflexibility in Meeting Regulations		/		//
9. Method Considered Cost Effective	/		/	/
10. Provides Standardized Training	/			/
11. Accommodates Student Differences	/		/	/
12. Increases Student/Equipment Contact Time	/			
13. Lack of Strong Management Support	//			
14. Low Quality Instructional Materials	//		//	/
15. Low Instructor Dedication/Motivation	/			/
16. Inadequate Instructor Role Training	/		/	/
17. No Provision of Student Orientation	/		/	
18. Frequent Student Feedback			/	
19. Enhancement of Student Confidence and Responsibility			/	

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
20. Shortage of Actual Training Equipment	/		//	//
21. Inadequate Fiscal/Resource Support for In-House Materials Development			//	/
22. Inadequate Student/Instructor Ratios	/		/	
23. Lack of Staff Involvement/Participatory Management	/		/	/
24. Well-Planned Facilities	/			
25. Low Student Motivation	/			
26. Ineffective Scheduling of Equipment			/	
27. Inadequate Student/Student Interactions			/	
28. Method Does Not Match Field Requirements	/		/	
29. Excessive Demands on Instructor Time and Skills			/	
30. Inflexible Use of 8-Hour Training Day			/	/

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Biomedical Equipment Maintenance (BEM) -
Successful Self-Paced Course

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
1. Adequate Mix of Media				/
2. Low Difficulty Level				/
3. High Student Motivation			/	/
4. Adequate Opportunity for Student/ Instructor Interactions			/	/
5. Effective Scheduling of Limited Equipment	/		/	
6. Frequent Rotation of Instructor Duties	/			
7. Enhancement of Student Confidence and Responsibility	/			
8. Provision of Student Orientation	/			
9. Adequate Student/Instructor Ratios	/		/	
10. Method Matched to Field Requirements	/			
11. High Instructor Dedication/Motivation	/			
12. Inadequate Instructor Role Training				/
13. Low Turnover of Instructors	/			
14. Instructors Can Specialize within Blocks	/			
15. Good for Performance Part of Course	/		/	/
16. Method Considered Cost Effective	/			
17. Continual ISD Process	/			
18. Flexible Implementation Approach	/		/	/
19. Frequent Student Feedback	/		/	

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
20. Flexibility in Meeting Regulations	/			
21. Staff Involvement/Participatory Management/Teaming				
22. Shortage of Actual Equipment/Cost Effective	/			

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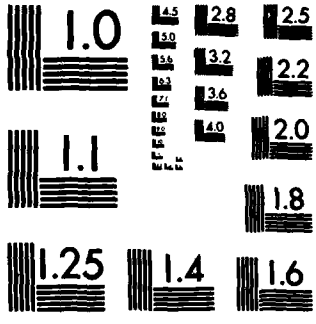

MICROCOPY RESOLUTION TEST CHART
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Radiologic Specialist (RS) -
Successful Self-Paced Course

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
1. Mix of Media			/	/
2. Effective Scheduling of Limited Equipment	/		/	/
3. Provision of Student Orientation			///	
4. Adequate Group and Team Activities				////
5. Adequate Opportunity for Student/ Instructor Interactions			///	
6. Method Matched to Field Requirements	/			
7. High Student Motivation				/
8. Frequent Rotation of Instructor Duties	/			
9. Adequate Opportunity for Student/ Student Interactions			/	
10. Adequate Student/Instructor Ratios			///	
11. Increases Student/Equipment Contact Time	/		/	/
12. Staff Involvement/Participatory Management	/		/	
13. Adequate Fiscal and Resource Support for In-House Materials Development	/		/	
14. Adequate Multilevel Staff Training	/			
15. Low Turnover of Instructors				
16. Flexible Implementation Approach				
17. Good for Performance Part of Course				
18. Elaboration of Material Presented in 1-5				

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
19. Method Considered Cost Effective	/			
20. Continual ISD Process	/			
21. Instructor Dedication/Motivation	/		/	//
22. Inadequate Instructor Role Training	/		/	/
23. Frequent Informal Communication with the Field				/
24. Flexible Use of 8-Hour Day				//
25. Infrequent Course Changes				//

Keesler AFB

Aircraft Control and Warning (ACW) -
Successful Cell-Paced Course

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
1. Flexible Implementation Approach	/			
2. Ability Level Tracking	/		/	
3. Adequate Opportunity for Student/ Instructor Interactions	//	/	/	
4. Low Emphasis on Completion Time	/			
5. Minimum Time Requirements on Each Lesson	/			
6. Flexible Use of 8-Hour Training Day	/			
7. Incorporation of Team and Group Activities	//	/		
8. Method Matched to Field Requirements	/	/		
9. Strong Management Support	/			
10. Well-Defined Instructor Roles	//	/		
11. Accommodates Student Differences	/		/	
12. Method Considered Cost Effective	/		/	
13. Adequate Remedial Programs	//		/	
14. Provision of Student Orientation				/
15. Student Self-Monitoring of Progress	/			

Keesler AFB

Aircraft Control and Warning (ACW) -
Unsuccessful Self-Paced Course

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
1. Instructor Assigned to One Block			/	
2. Too Much Emphasis on Completion Time	//			
3. Inadequate Opportunity for Student/ Instructor Interactions	/		/	
4. Ineffective Scheduling of Limited Equipment	//	/		
5. Method Not Matched to Field Requirements	//			
6. Excessive Demands on Instructor Time and Skills	/		/	
7. Inadequate Student/Instructor Ratios	/			
8. Instructor Roles Not Well-Defined	/			
9. Not Considered Cost Effective			/	
10. Low Instructor Dedication/Motivation	/			

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Aircraft Control and Warning (ACW) -
Factors Critical to Both Modes

Critical Factors	Training Development Specialists	Branch Chief	Instructors	Supervisors
1. Inadequate Instructor Role Training	/		/	
2. Slow Turnaround on Material Revisions				/
3. Student Reading Ability			///	/
4. No Provision for Lecture			/	
5. Breakdown of Computer-Simulated Equipment			/	
6. Quality Instructional Materials	/			
7. Match of Text with Student Reading Level	/			
8. Stable Instructor Staff				/
9. Staff Involvement/Participatory Management			/	/
10. High Student Motivation			/	/
11. Mix of Media	/			

APPENDIX D

Definition of Critical Factors

CRITICAL FACTORS

(From Figure 2)

Student Issues

High Student Reading Ability: The ability of a student to read and comprehend printed materials at the 9th grade level or above in self-paced courses that make heavy use of programmed texts.

High Student Motivation: The ability of a student to employ appropriate self-motivation skills and to maintain high levels of interest in doing well in self-paced courses.

High Student Maturity: The ability of a student to apply self-management, personal responsibility, and self-directed learning skills in a self-paced course.

Instructor Issues

Instructor Dedication/Motivation: High levels of instructor understanding, dedication, and motivation to perform well in a self-paced method of instruction.

Implementation Issues

Instructor Remains with Single Class: An implementation of the self-paced method wherein a small class of students stays with the same instructor for the duration of the self-paced course.

Flexible Implementation Approach: An approach to the management and implementation of self-pacing wherein flexible and creative solutions to problems with the method are implemented (e.g., embedding group activities within the self-paced context).

Flexible Use of 8-Hour Training Day: The implementation of flexible class schedules within the 8-hour training day such that there is adequate time for student remediation and other instructor duties (e.g., curriculum writing).

Effective Scheduling of Limited Equipment: Deliberate efforts on the part of management and instructor personnel to come up with creative and flexible solutions to the scheduling of limited equipment items in a self-paced course.

Adequate Opportunity for Student/Instructor Interactions: The deliberate attempts within a self-paced course to set up specific opportunities for student/instructor interactions; these could include small group

discussions as well as defined instructor roles and procedures that include student/instructor interactions.

Incorporation of Team and Group Activities: The provision within a self-paced format for periodic team and group activities to supplement individual activities.

Limited Clerical/Record Keeping Duties for Instructors: The careful planning of instructor duties such that there is a minimum amount of clerical and record keeping responsibilities; could include the use of noninstructor personnel for these activities or rotation of duties.

Adequate Procedures for Handling Test Security: The establishment of formalized procedures within a self-paced course for ensuring test security and reducing student cheating.

Instructors Assigned to One Block: The implementation of self-pacing such that instructors are responsible for managing and facilitating student learning in one block rather than requiring them to be responsible for the technical content of the entire course.

Accommodates Student Differences: Providing a variety of activities or instructional formats to accommodate differences in student ability in a self-paced course.

Increases Student/Equipment Contact Time: The use of flexible equipment management and scheduling procedures such that students have maximum individual opportunity to perform on equipment.

Frequent Student Feedback: The incorporation of procedures for giving students systematic, periodic feedback as to their level of performance and progress in a self-paced course.

Accommodates Individual Student Projects: The implementation of effective course management and scheduling procedures such that students can be assigned to individual projects.

Accommodates Student Learning Preferences: The use of self-paced, group or multimedia techniques that are matched to student entry characteristics and preferences for particular learning modes.

Effective Manual Student Tracking: The establishment of effective formalized procedures for manually tracking student performance and progress in a self-paced course.

Provision of Student Orientation: The use of formalized procedures or materials for orienting students to the requirements and responsibilities for learning in a self-paced environment.

Located at Student's Home Base: The implementation of a self-paced course at the students' home base rather than requiring them to travel to another base.

Management Issues

In-House Development and Implementation: The ability of a course to have responsibility for the development and implementation of self-pacing; includes staff expertise and resources.

Continual ISD Process: The dedication of course management personnel to the continual evaluation and revision of its self-paced materials and procedures based on an application of the ISD process.

Method Matched to Field Requirements: The deliberate attempt to select and modify the self-paced format to accommodate field requirements such as teaming.

Method Considered Cost Effective: The perception of or evidence for self-pacing resulting in the reduction of or a more effective use of resources to achieve equal or better training outcomes.

Permits Higher Student Flow: The recognition by course management personnel that the self-paced method will affect particular training requirements by allowing higher student flow.

Staff Involvement/Participatory Management: The deliberate attempts by course management to involve supervisory and instructor staff in decisions regarding the design and implementation of self-pacing.

Strong Management Support: The presence of strong support for the self-paced method among course and upper management personnel (group and school).

Deliberate Efforts to Keep Instructor Motivation High: The implementation by course management of specific techniques and procedures for keeping instructor motivation high in self-paced courses; includes the use of reward systems, staff involvement, and frequent rotation of instructor duties.

Well Defined Instructor Roles: The deliberate attempt by course management to define and communicate instructor role requirements in a self-paced course.

Adequate Instructor Role Training: The formal provision of instructor training in the roles required of them in a self-paced course.

Deliberate Efforts to Convince Higher Management of Benefits: The dedication of course management to self-pacing and their willingness to make deliberate attempts to convince higher management of the benefits of self-pacing.

Separation of Self-Paced and ISD Issues: The understanding by course management personnel of the differences between self-paced and ISD issues and their tendency not to blame self-pacing for ISD failures such as poor quality materials.

Multilevel Staff Orientation/Training: The deliberate attempts by course management to provide orientation and training in self-paced procedures to all levels of staff.

Low Emphasis on Completion Times: The pervasive attitude within a self-paced course that the quality of student performance will not be sacrificed to short course completion times in an effort to prove cost effectiveness.

Frequent Rotation of Instructor Duties: The implementation by course management of procedures that allow instructors to rotate frequently between testing, lab, and classroom areas as well as to rotate responsibilities in these areas.

Flexibility in Meeting Regulations: The pervasive attitude among course management personnel that self-pacing can be accommodated by course regulations and the willingness to come up with creative solutions to problems encountered in meeting regulations that were designed for lockstep courses.

Infrequent Course Changes: The selection of the self-paced method for courses that do not require frequent course changes due to frequent changes of methods or equipment in the field.

Adequate Student/Instructor Ratios: Efforts on the part of course management to establish student/instructor ratios that maximally meet student, instructor, and course needs.

Instructional Materials Issues

Quality Instructional Materials: The presence of instructional materials of adequate quality, matched to student needs, and in an appropriate format for specific learning requirements (e.g., text vs. CAI vs. hands-on job aids).

Standardized Training Curriculum: Recognition of the benefits of self-pacing in providing a standardized training curriculum that provides consistent training content.

Mix of Media: The provision in course design and implementation of instructional materials in a variety of formats and media, including the use of CAI where appropriate.

Method Matched to Knowledge/Performance Requirements: The design of a self-paced course and materials such that they are matched to the particular knowledge and/or performance requirements of that course (e.g., appropriate use of printed materials, individual and group activities).

Facilities/Equipment Issues

Well Planned Facilities: The careful design of facilities for self-paced courses such that they accommodate student, instructor, and training needs.

Equipment Broken into Components (Trainers): The selection of self-pacing as a method for courses in which equipment for the performance portions can be broken into component parts or trainers; facilitates equipment management and scheduling and increases student/equipment contact time.

Reliable Computer Equipment: The use of computer equipment in CAI or CMI applications of self-pacing that has a high level of reliability and low down times.

Sufficient Number of Terminals: The presence of enough computer terminals within a self-paced course to efficiently handle student load requirements for CAI or CMI activities.

Low Requirements for Large, Expensive Equipment: A characteristic of a particular performance-based training specialty wherein there is a minimum requirement for large, one-of-a-kind equipment of part-task trainers; enhances resource management and scheduling when combined with flexible scheduling approaches and/or flexibilities in course hierarchies so as to permit a variety of parallel performance activities.

Resource Issues

Adequate Fiscal/Resource Support for In-House Materials Development: The presence of sufficient monetary, personnel, and support resources to develop quality instructional materials in a self-paced course; related to management support and commitment to the self-paced method.

Sufficient Number of Instructors for Materials Development: The deliberate attempts by course management to assign sufficient numbers of instructors to curriculum writing responsibilities without sacrificing student/instructor ratios in the classroom or adding extra burdens on instructor time and skills.

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